The Macroeconomics of Pandemics in Developing Countries: an Application to Uganda

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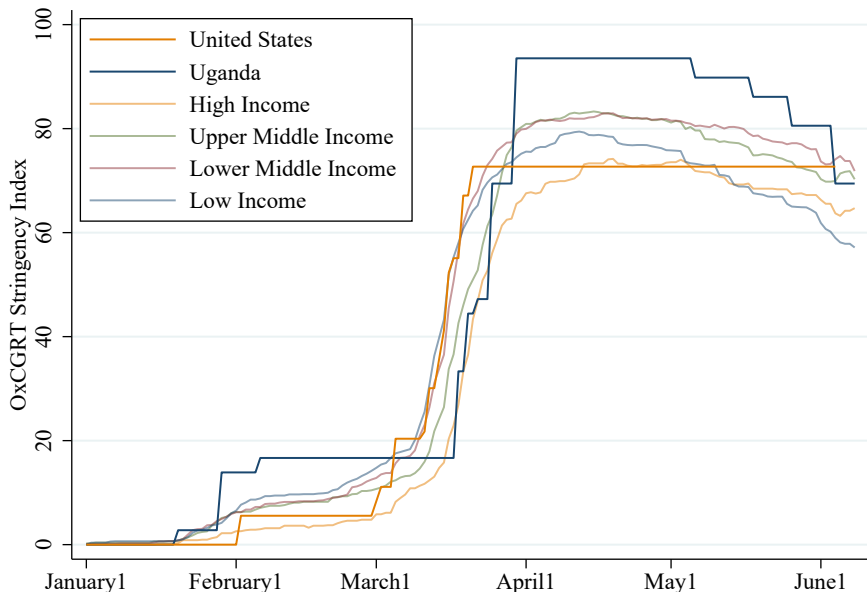
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Lockdown stringency across countries

Motivation

- Similar measures against COVID-19 pandemic across countries
- Early models of the pandemic justified widespread restrictions
    - Eichenbaum et al. (2020); Farboodi et al. (2020); Glover et al. (2020)
- Emerging evidence of economic hardship through lockdowns
    - Mahmud and Riley (2020); Moscoviz and Le Nestour (2020); Brac (2020)
- Development economists critical of chosen policies
    - Ray and Subramanian (2020); Barnett-Howell and Mobarak (2020); Ravallion (2020)

$\Rightarrow$ Do mortality risks differ across countries?
$\Rightarrow$ Do welfare-optimizing policies differ across countries?

# Predicting infection fatality rates for COVID-19

- How to estimate the share of infected that may die from the disease (IFR) in a country if one doesn't know...?
  - ... the true number of COVID-19 infected
  - ... nor the true number of COVID-19 deaths
- We rely on medical data from high-income countries and account for different...
  - ... age-sex distributions
  - ... comorbidities
  - ... health system capacities
- Using Bayes Rule, we can estimate the IFR conditional on age (a), sex (s) and comorbidities (c)

$$cIFR = P_{las}(d|c) = \frac{P_{las}(c|d)}{P_{las}(c)} P_{las}(d)$$

Predicted infection fatality rates for COVID-19

Based on demography, comorbidities, and health system capacity

0   0.022
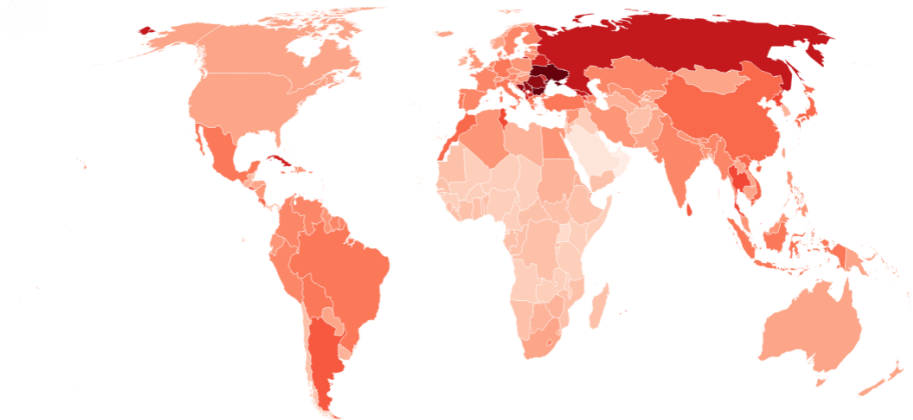
Source: Ghisolfi et al (2020)

Do welfare-optimizing policies differ across countries?

- We build on recent contributions on welfare maximizing policy in the United States (Eichenbaum, Rebelo, Trabandt, 2020)
- We calibrate and extend their model to better reflect dimensions important in developing countries
  - Lower incomes (GDP/capita at $710 in Uganda, $54,000 in US) & subsistence constraints
  - IFRs calculated for Uganda (age, comorbidities, health system)
  - Access to vaccines
- How do implications of the model differ when using different valuations of life?

Model

- ERT model combines epidemic and economic components
- Epidemic part is a **S**usceptible-**I**nfected-**R**ecovered model (t=1 week)

$$S_{t+1} = S_t - \pi_i S_t I_t$$
$$I_{t+1} = (1 - \pi_r) I_t + \pi_i S_t I_t$$
$$R_{t+1} = R_t + \pi_r I_t$$
$$D_{t+1} = D_t + \pi_d I_t$$

- How much agents consume and work affects infections

$$I_{t+1} = (1 - \pi_r) I_t + \underbrace{\pi_{i1} (S_t C_t^s) \left(I_t C_t^i \right)}_{\substack{\text{Infections} \\ \text{from consuming}}}$$

$$+ \underbrace{\pi_{i2} (S_t N_t^s) \left(I_t N_t^i \right)}_{\substack{\text{Infections} \\ \text{from working}}} + \underbrace{\pi_{i3} S_t I_t}_{\substack{\text{infections from} \\ \text{random interactions}}}$$

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Key assumptions of the model

- Agents' consumption cannot fall below a certain level

$$u\left(c_t, n_t\right) = \ln\left(c_t - \bar{c}\right) - \frac{\theta}{2}n_t^2 + \bar{u}$$

- Agents realize the likelihood and dangers of getting infected
  - voluntary reductions in economic activity to reduce infection risk

$$\text{Susceptible: } U_t^s = u\left(c_t^s, n_t^s\right) + \beta\left[\left(1 - \tau_t\right)U_{t+1}^s + \tau_t U_{t+1}^i\right]$$
$$\text{where: } \tau_t = \pi_{s1}c_t^s\left(I_t C_t^I\right) + \pi_{s2}n_t^s\left(I_t N_t^I\right) + \pi_{s3}I_t$$
$$\text{Infected: } U_t^i = u\left(c_t^i, n_t^i\right) + \beta\left[\left(1 - \pi_r - \pi_d\right)U_{t+1}^i + \pi_r U_{t+1}^r\right]$$
$$\text{Recovered: } U_t^r = u\left(c_t^r, n_t^r\right) + \beta U_{t+1}^r$$

- But they neglect their contribution to spreading the epidemic
  - potential efficiency gain through lockdown policy

Model

- The government sets a containment rate
  - 'measures aimed at reducing interactions' which affect consumption
  - modeled via agents' budget constraint $\qquad (1 + \mu_{ct}) c_t = w_t n_t + \Gamma_t$
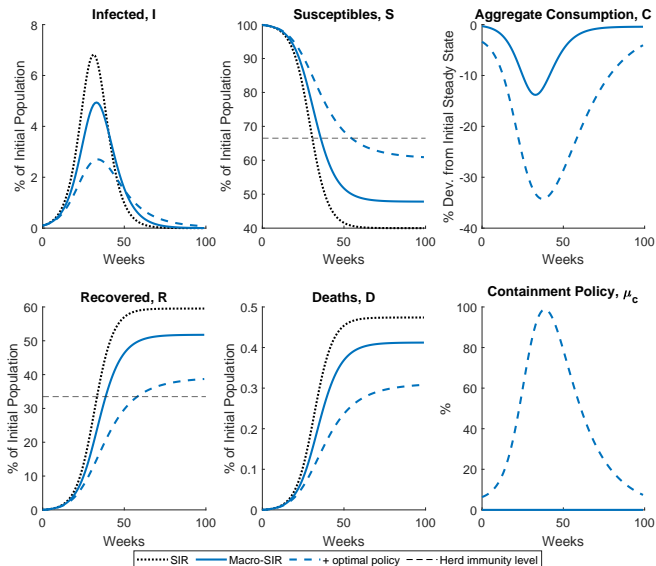
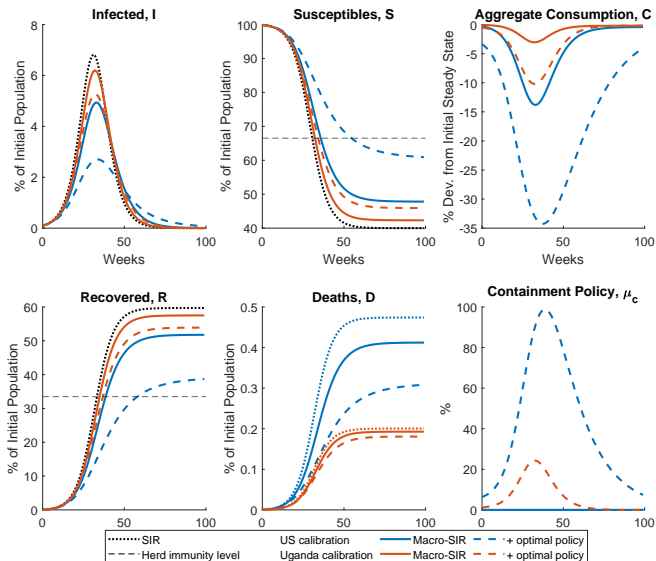$\Rightarrow$ What timepath of containment maximizes aggregate utility?

Calibration

	Uganda	United States
Income/year	$535	$58,000
Hours worked/week	50	28
Subsistence level	$200	$200
Value of statistical life	$31,000[a]	$9.3 million
IFR	0.33%	0.79%

[a] $VSL_{US} * \frac{GDPpc_{UG}}{GDPpc_{US}} * \frac{Health\ Spending_{UG} / GDP_{UG}}{Health\ Spending_{US} / GDP_{US}}$
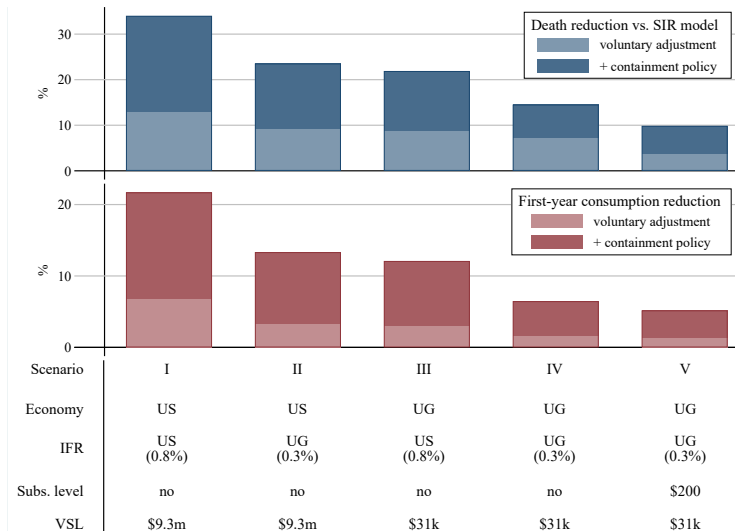
Benchmark calibration to US

Calibration to Ugandan economy & IFR

Summary of calibration steps

| Scenario	I	II	III	IV	V
Economy	US	US	UG	UG	UG
IFR	US (0.8%)	UG (0.3%)	US (0.8%)	UG (0.3%)	UG (0.3%)
Subs. level	no	no	no	no	$200
VSL	$9.3m	$9.3m	$31k	$31k	$31k

Waiting for a vaccine?

- What if governments imposed strict lockdowns because they think a treatment or a vaccine may come?
- So far in the model, the only way out of the epidemic is herd immunity
- How does optimal policy change if the social planner hopes for a vaccine to arrive?
- Agents now expect that in every period, a vaccine may become available with a certain probability
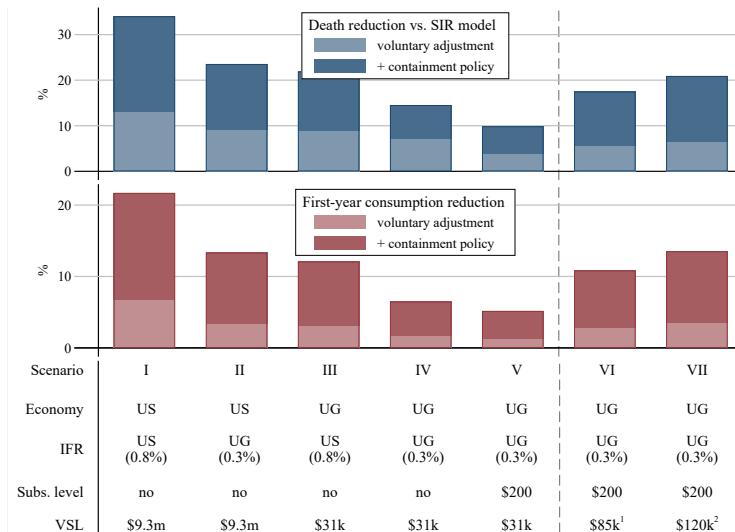
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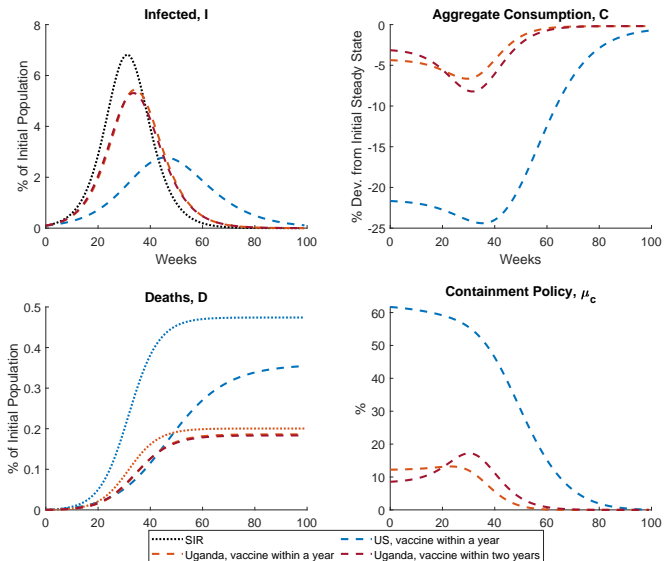
Valuations of life

- How to think of a valuation of life? Lost utility.

- Is there a relevant number to target? Revealed preferences by authorities.
  - For the US we have such a number: $9.3 mill.
  - For Uganda: scale to spending on health per capita.
    - Alternative calibrations: scale to income or GDP per capita (PPP adjusted).
    - Follow Viscusi and Masterman (2017): GNI
    - We also show results for using our mean individual incomes that we use to calibrate the model.

Valuations of life

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IFR	US (0.8%)	UG (0.3%)	US (0.8%)	UG (0.3%)	UG (0.3%)	UG (0.3%)	UG (0.3%)
Subs. level	no	no	no	no	$200	$200	$200
VSL	$9.3m	$9.3m	$31k	$31k	$31k	$85k[1]	$120k[2]

[1] prop to incomes in Uganda versus the US   [2] following Viscusi and Masterman (2017)

Conclusion & next steps

- We calculate IFRs accounting for age, comorbidity and health system differences between countries,
    - our estimates are substantially higher than those by the WHO.
- Based on a simple economic framework, the same logic that justifies strict containment policies in the US suggests more lenient measures in poorer and younger countries.
- So why do we see lockdowns everywhere?
    - Uncertainty around the epidemic - better data over time.
    - Do individuals fear the virus more than necessary, and thus demand strong action?
- In progress: value of life/life years.
    - It is possible that government in different countries have different evaluations.

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