Macroeconomic Effects of COVID-19 Across the World Income Distribution

Titan Alon [1] Minki Kim [1] David Lagakos [2] Mitchell VanVuren [1]

[1]University of California San Diego

[2]Boston University and NBER

Fundacao Getulio Vargas - Nov 8 2021

Emerging Market Most Severely Affected by the Pandemic

- GDP fell more in emerging markets than in either richer or poorer countries
- Excess deaths per capita relatively higher in emerging markets
- Why? Different fundamentals?’ Different policies?

Emerging Market Most Severely Affected by the Pandemic: Why?

Our approach: quantitative analysis using macro model with disease spread

Key cross-country differences in model

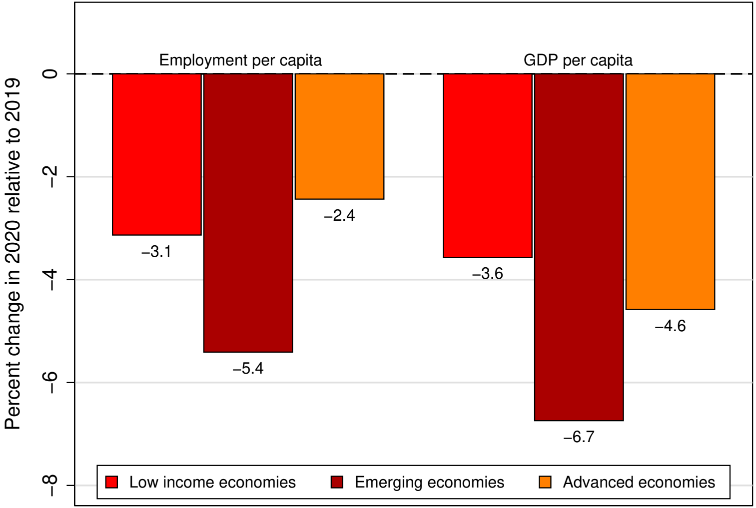
1. Size of "social" sector (requiring face-to-face interactions)
2. Age structure of population
3. Intensity of lockdowns
4. Intensive care capacity in healthcare system
5. Extent of government transfers (work in progress)

Quantitative Conclusions So Far

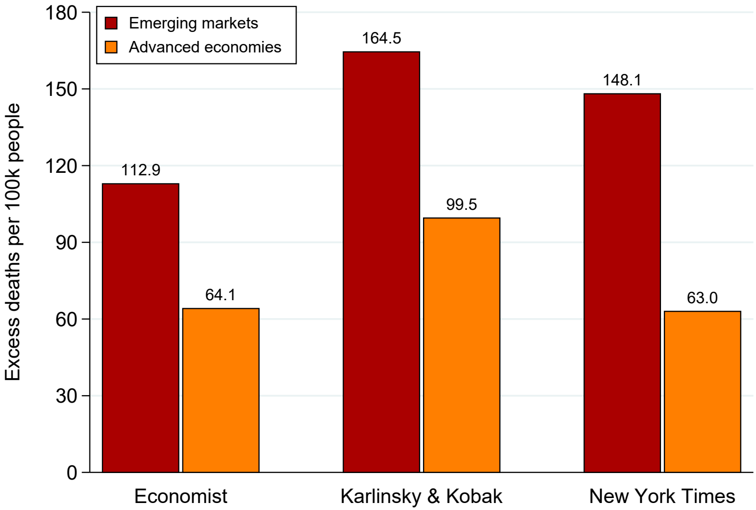
- Bigger GDP declines in emerging markets largely due to higher social employment shares
- Model predicts higher mortalities in emerging markets but under-predicts data
- Low-income countries fared better largely due to much younger population and high "non-social" employment

Facts

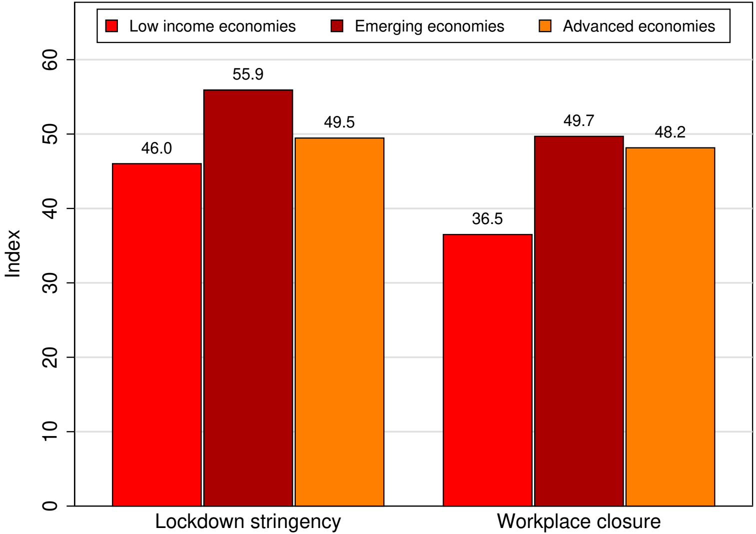
Employment and GDP Changes, 2019 to 2020



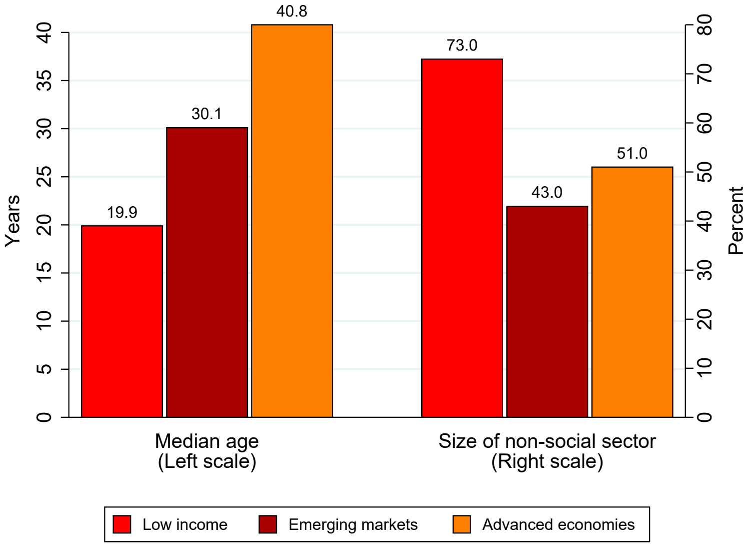
Excess Deaths per 100,000 People



Lockdown Intensity Index



Median Age and "Non-Social" Share in Employment



Model

Two-Sector Heterogeneous Agent Model + Epidemiology

Epidemiology

- SICR with age heterogeneity as in Glover et al. (2020): two age groups

Households

- Face uninsured idiosyncratic labor income risk and health risk
- Accumulate assets endogenously, face credit constraint

Two sectors

- Social: remote work entails large productivity loss
- Non-social: can work remotely with little productivity loss

Government

- Imposes containment policies and administer vaccines
- Collects taxes and makes transfers but with limited fiscal capacity

Households and Preferences

- Young adults represent fraction ω_y of population; old: $1 - \omega_y$
- Preferences (of the living):

$$\mathbb{E}\left[\sum_{t=0}^{\infty} \beta_j^t \log(c_t) + \bar{u}\right]$$

- β_j is discount factor of age group j, where $j \in \{y, o\}$
- $\bar{u}$ is the flow value of being alive

Sector and Idiosyncratic Shocks

- Individuals are assigned to one of the two sectors; $s \in \{S, N\}$:
  1. Social sector (ω_S) : occupations with little room for remote work

     e.g. waitress, hairdresser

  2. Non-social ($1 - \omega_S$): occupations which can be done remotely

     e.g. professors, subsistence farmers

- Individuals face idiosyncratic productivity shock as in Aiyagari (1994)

$$\log v_{t+1} = \rho_v \log v_t + \varepsilon_{t+1} \quad \text{with} \quad \varepsilon_{t+1} \overset{iid}{\sim} F(0, \sigma_v)$$

Assets and Individual's Budget Constraint

- Borrowing limit: $a \geq \bar{a}$
- Individuals in sector s have the following budget constraint:

$$c + a' \leq (1 - \tau) w_s z v n + (1 + r) a + T$$

$$n = \begin{cases} 1 & \text{if go to workplace} \\ \phi_s & \text{if work remotely or under lockdown} \end{cases}$$

Regular and Remote Work

- Workers can choose to work remotely
- Remote work involves less social contact, hence safer
- However, remote work also entails productivity loss

$$\text{Labor income} = \begin{cases} w_t \times v & \text{if go to workplace} \\ \phi_s \times w_t \times v & \text{if work remotely} \end{cases}$$

- ϕ_s: productivity penalty of remote work, $0 \leq \phi_S \leq \phi_N \leq 1$

Production and Firm Profit Maximization

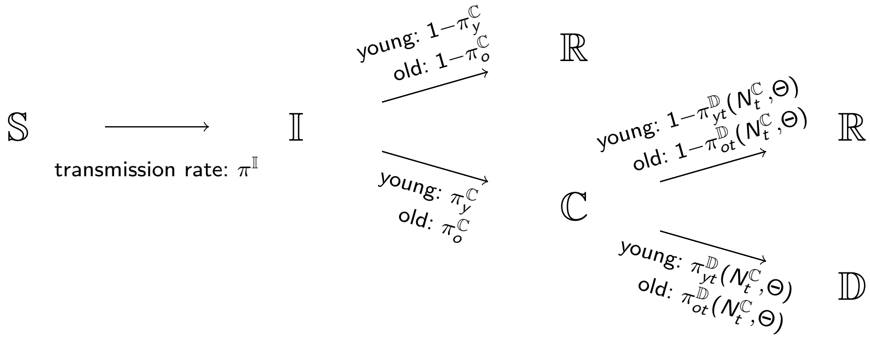
- Final good technology:

$$Y = AL^{\alpha}K^{1-\alpha}, \quad 0 < \alpha \leq 1$$
$$L = L_S + L_N$$

- K rented at exogenously given international rental rate r^F

Health States and Transitions

- Being infected drops all productivities by fraction $0 < \eta \leq 1$ until recovery
- Being critical drops all productivities to 0 until recovery



Virus Contagion + Infection Probabilities

- Baseline probability a susceptible person becomes infected is:

$$\pi_t^{\mathbb{I}} = \beta_t^{\mathbb{I}} \times N_t^{\mathbb{I}} / N_t$$

- $\beta_t^{\mathbb{I}}$ is exogenous time-varying infection rates
  - represents e.g. more masking, better treatments, cold weather, new variants

Hospital Capacity + Death Probabilities

- Θ is maximum ICU capacity per capita ($0 < \Theta < 1$)
- Probability of receiving an ICU bed is $\min\{\frac{\Theta}{N_t^{\mathbb{C}}}, 1\}$
- Fatality rate $\pi_{jt}^{\mathbb{D}}$:

$$\pi_{jt}^{\mathbb{D}}(N_t^{\mathbb{C}}, \Theta) = \begin{cases} \pi_j^{\mathbb{D}} & \text{if assigned ICU bed} \\ \kappa \times \pi_j^{\mathbb{D}} & \text{if not assigned} \end{cases}$$

- $\pi_j^{\mathbb{D}}$: baseline fatality rate of an age group j patient
- κ governs the impact of hospital overuse on fatality rate

Voluntary Substitution Away From Workplace and Lockdowns

Voluntary Substitution

- Working remotely lowers the probability of infection:

$$\pi^{\mathbb{I}} = \begin{cases} \beta^{\mathbb{I}} \times N^{\mathbb{I}}/N & \text{if go to workplace} \\ \beta^{\mathbb{I}} \times N^{\mathbb{I}}/N \times \xi & \text{if work remotely} \end{cases}$$

$0 \leq \xi < 1$: represents how much safer remote work is

Lockdown

- Randomly select λ fraction of each (young, old) $\times$ (social, non-social) groups
- Selected individuals are forced to work from home
- $0 \leq \lambda \leq 1$: lockdown intensity, which varies across countries

Choice of Regular or Remote Work

- In each period, susceptible individuals choose regular or remote work

$$V = \max\{V^w + \varepsilon_w, V^r + \varepsilon_r\}$$

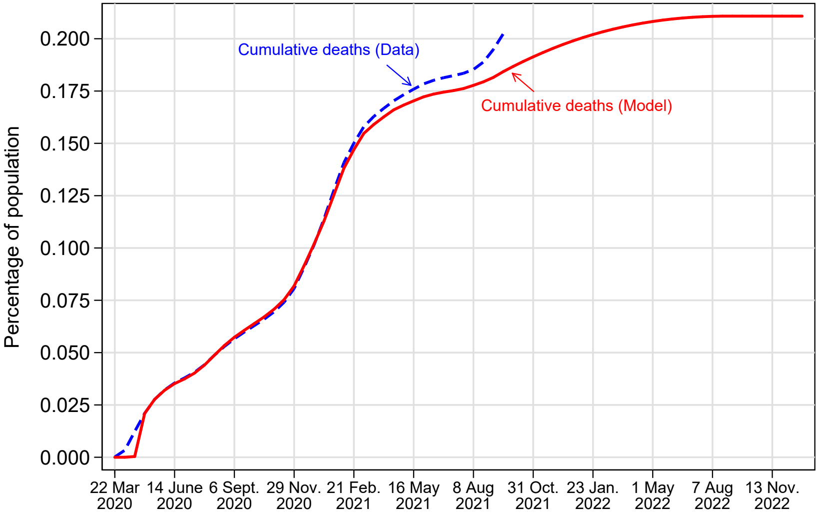
where ε_x, $x \in \{w, r\}$: independently distributed Gumbel taste shock

- Recovered / vaccinated individuals are not subject to lockdown

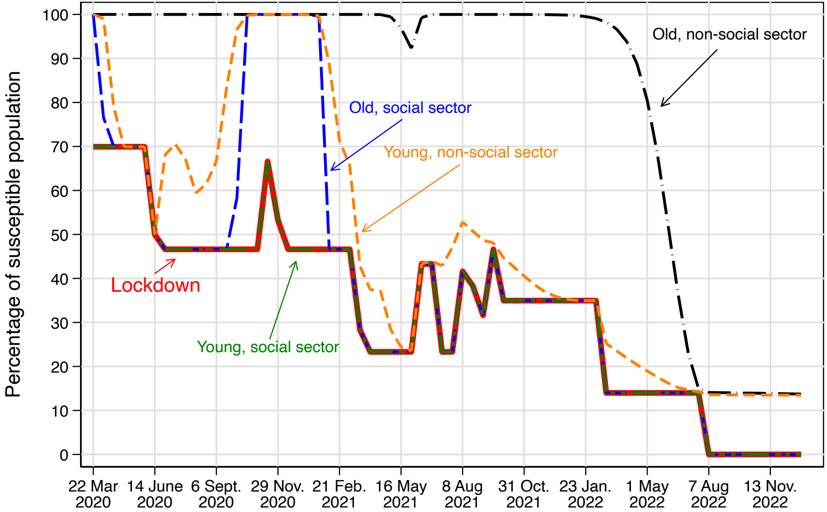
Calibration Summary

- Calibrate model to match US time series
- Death rates by age taken from epidemiology literature
- Income process and macro parameters taken from literature
- Penalties for work from home: 0% for Non-social; 28% for Social
- Vaccination rates taken directly to match U.S. data
- Time-specific infection probability taken to match U.S. cumulative deaths

Predicted vs. Actual U.S. COVID-19 Deaths



Patterns of Remote Work During the Pandemic



Counterfactual Simulations

Counterfactual Simulations

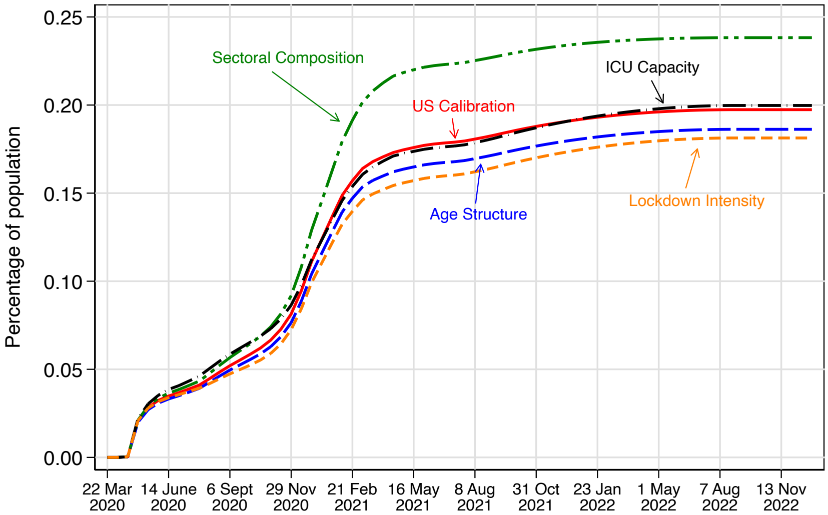
1. Suppose the U.S. had the characteristics of emerging markets.

   How would excess deaths have differed?

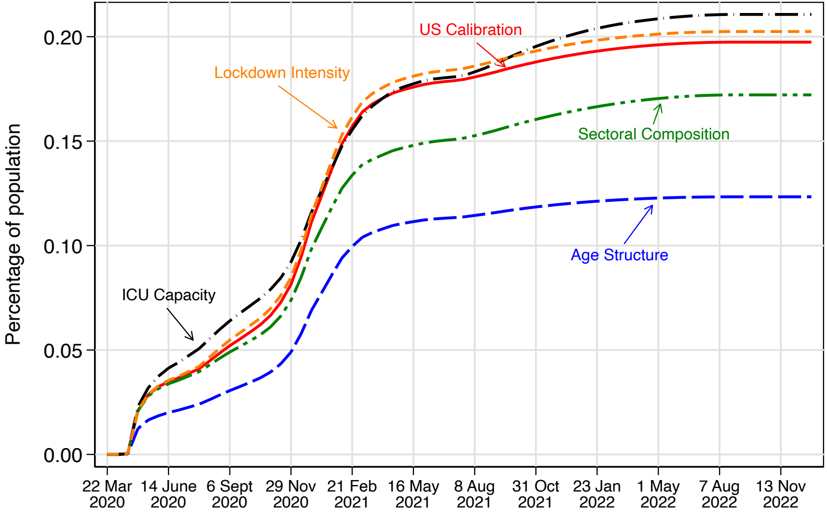
   How would GDP per capita have differed?

2. What if the U.S. had the characteristics of low-income economies?

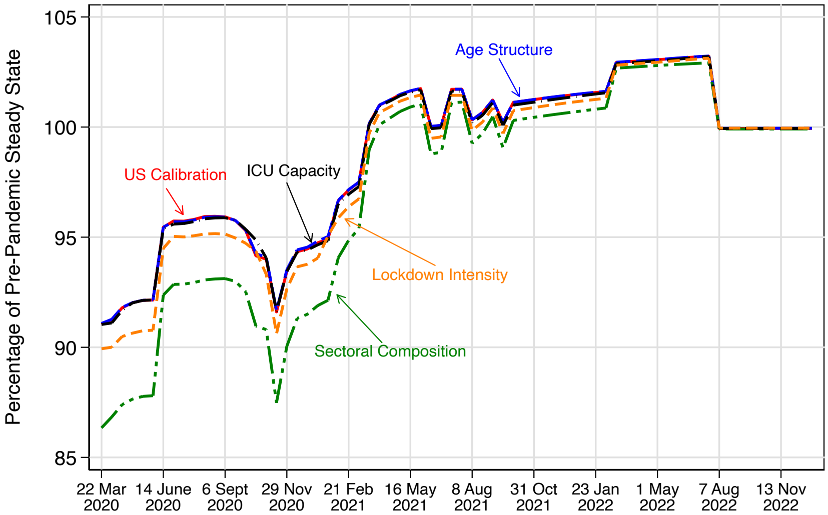
Counterfactual Deaths: U.S. with Emerging Markets' Features



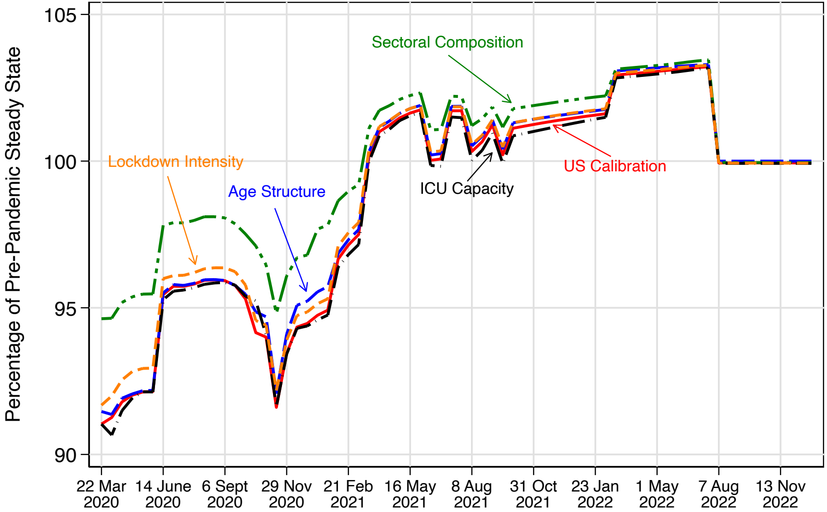
Counterfactual Deaths: U.S. with Low-Income Economies' Features



Counterfactual GDP: U.S. with Emerging Markets' Features



Counterfactual GDP: U.S. with Low-Income Economies' Features



Summary of the Counterfactual Exercise: Emerging Markets

Panel (a): GDP Changes from 2019 to 2020			
	Data	Model	
		All Features	Age/Sector/ICU
Advanced Economies	-4.60	-4.01	-4.01
Emerging Economies	-6.70	-7.36	-6.40
Ratio	1.46	1.84	1.60

Panel (b): Excess Mortality			
	Data	Model	
		All Features	Age/Sector/ICU
Advanced Economies	64.10	197.39	197.39
Emerging Economies	112.90	208.03	236.55
Ratio	1.76	1.05	1.20

Table: Cumulative Counterfactual Effects of the COVID-19 Pandemic

Conclusions So Far

- Macro outcomes particularly severe in emerging markets during pandemic

- Quantitative results so far from macro-epidemiology model:

  - Emerging markets worse in large part due to higher shares of "social" employment

  - Low-income economies escaped largely due to lower social employment shares & younger age structure

Future Work (Hopefully For Others too...)

- Model still greatly under-predicting deaths in emerging markets
- Pandemic transfers differed across countries; still need to add this
- More broadly, other factors absent here likely relevant for why emerging markets did particularly worse
- These include: mask prevalence, other co-morbidities, school closing policies, vaccine rollouts ...

Extra Slides