# Macroeconomic Effects of COVID-19 Across the World Income Distribution

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**IMF ARC**

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# 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 differences of emerging market economies

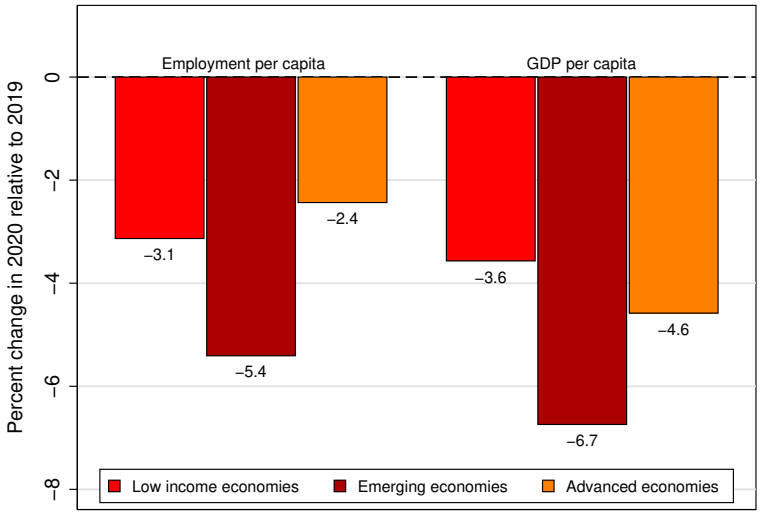
1. Large "social" sector requiring face-to-face interactions
2. Young populations (though not as young as low-income countries)
3. Strict lockdowns
4. Low healthcare capacity (though better than low-income countries)
5. Smaller transfers (work in progress)

# Quantitative Conclusions So Far

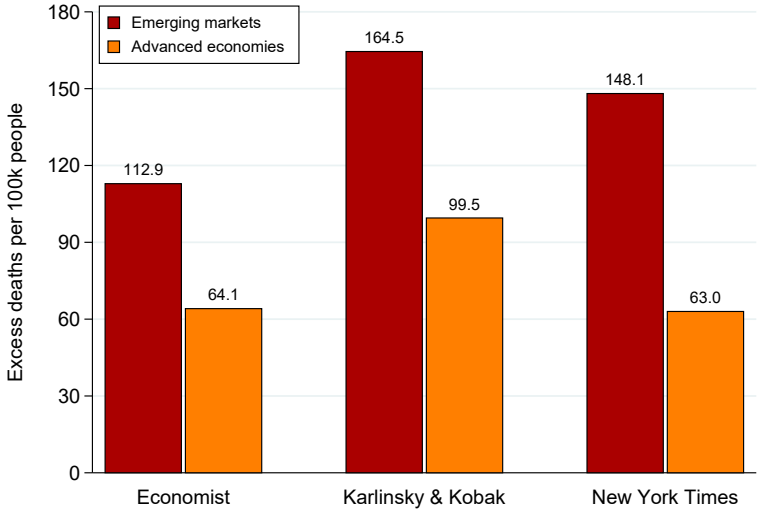
- Bigger GDP declines in emerging markets largely due to higher social employment shares & stricter lockdowns
- Model predicts higher mortalities in emerging markets but under-predicts data
- Low-income countries fared better largely due to much younger population and high "non-social" employment

# Facts

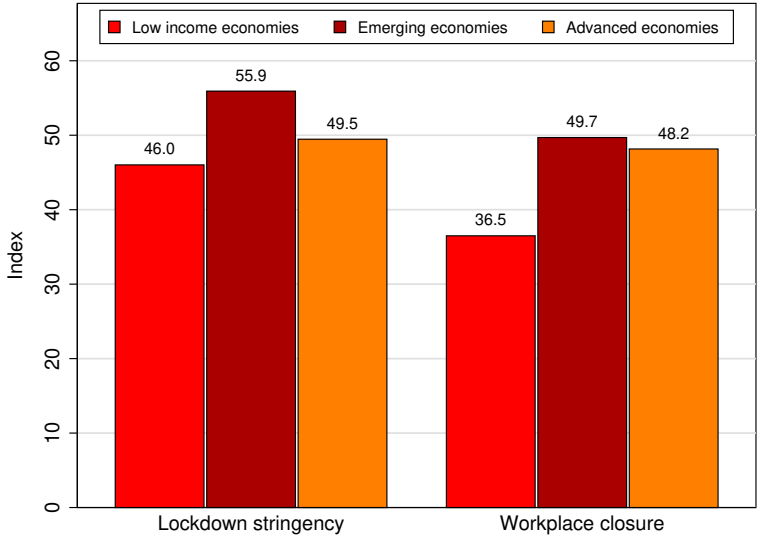
# Employment and GDP Changes, 2019 to 2020



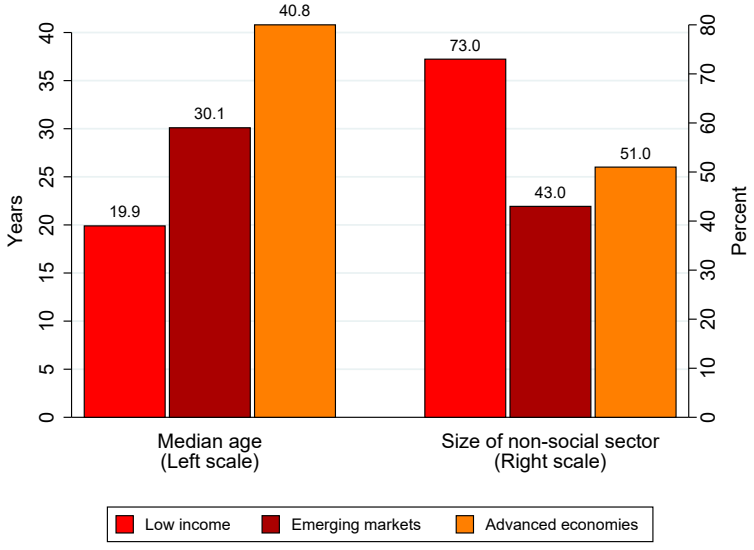
# Excess Deaths per 100,000 People



# 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

- Two age groups: young adults ($\omega_y$) and old ($\omega_o$)
- Preferences (of the living):

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

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

# Sector, Permanent Productivities and Idiosyncratic Shocks

- Individuals are assgined to one of the two sectors; $s \in \{S, N\}$:
  1. Social sector ($\omega_S$) : occupations with little room for remote work
     Examples: Waitress, hair dressers
  2. Non-social ($\omega_N$): occupations which can be done remotely
     Examples: Professors, subsistence farmers
- Individuals are also endowed with a permanent productivities $z \sim G$
- Individuals face idiosyncratic productivity shock as in Aiyagari (1994)

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

# Regular and Remote Work

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

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

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

# Assets and Individual's Budget Constraint

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

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

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

# Production and Firm Profit Maximization

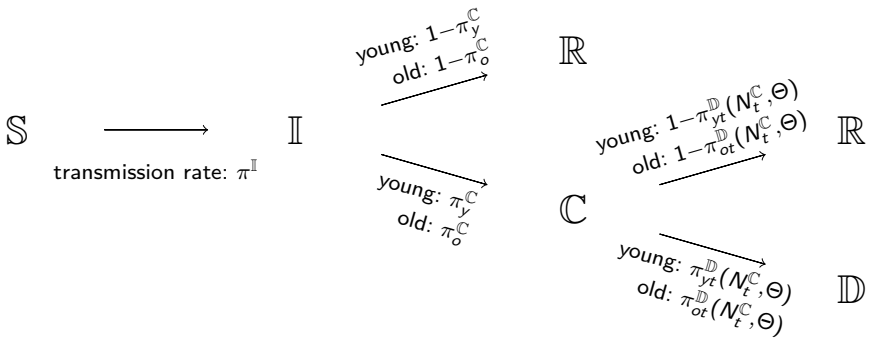
- Final good technology:

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

- $K$ 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

- 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
  - E.g. more social distancing or masking, better treatment

# 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 $\lambda$ 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

# Voluntary Substitution Away From Workplace and Lockdowns (continued)

- In each period, susceptible individuals can choose between working remotely and going to workplace by choosing the option with higher value

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

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

- Recovered / vaccinated individuals are not subject to lockdown

# Hospital Capacity

- $\Theta$ 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
- $\kappa$ governs the impact of hospital overuse on fatality rate

# Calibration Summary

Calibrate model to match US time series

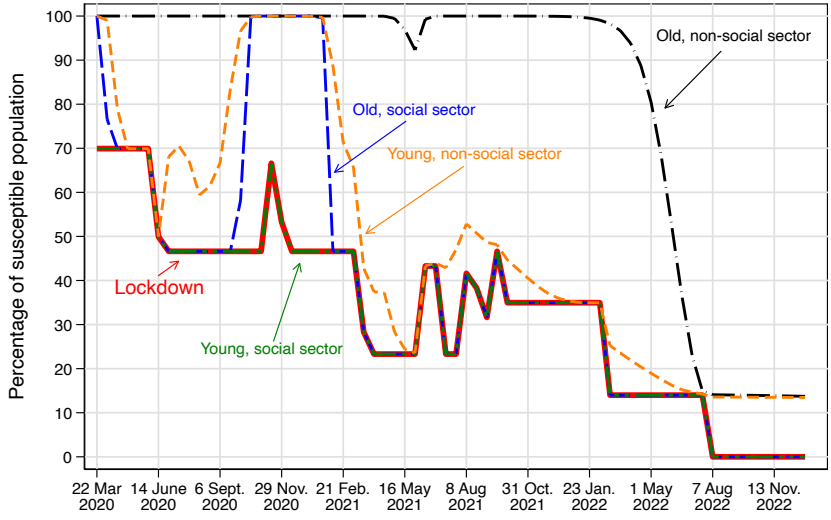
Death rates by age taken from epidemiology literature

Income process and macro parameters taken from literature

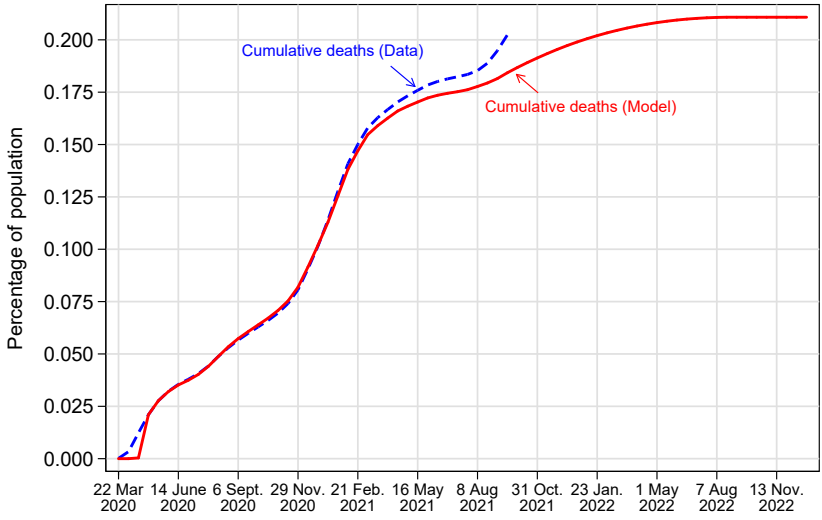
Penalties for work from home: 0% for Non-social; 28% for Social

Time-specific infection probability taken to match U.S. cumulative deaths

# Patterns of Remote / Regular Work Along the Path of the Pandemic



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



# Counterfactual Simulations

# Counterfactual Simulations

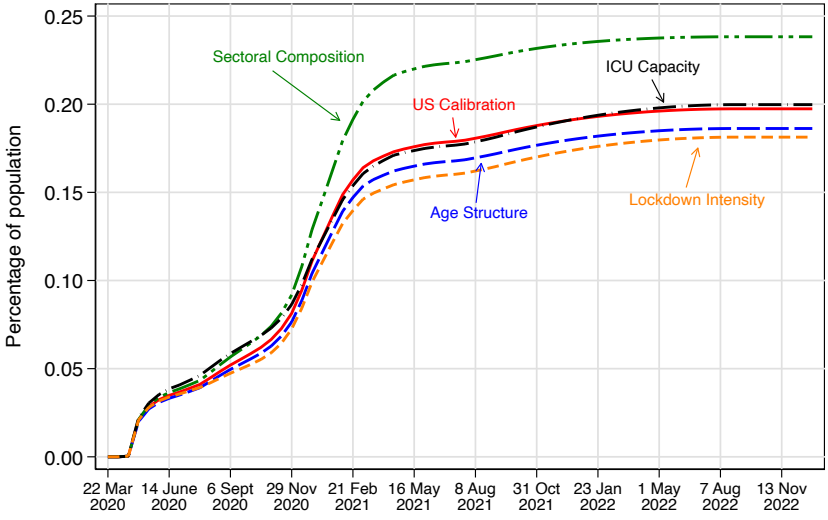
1. What would U.S. deaths have been if the U.S. had the characteristics of ....

   ... emerging market economies?

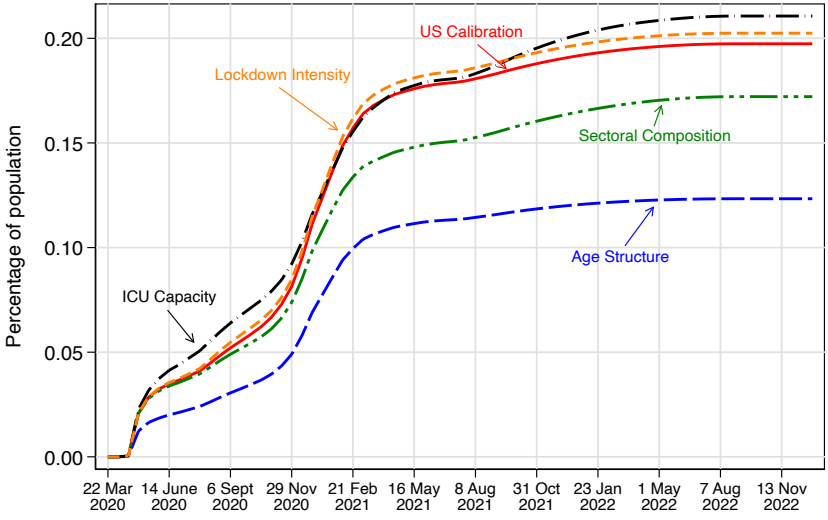
   ... low-income economies?

2. What would U.S. GDP have been ....?

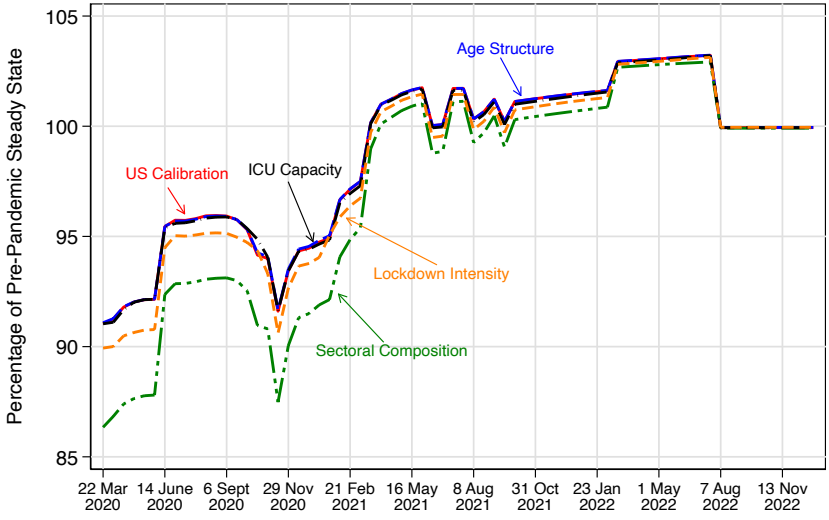
# Counterfactual Deaths: U.S. with Emerging Markets' Features



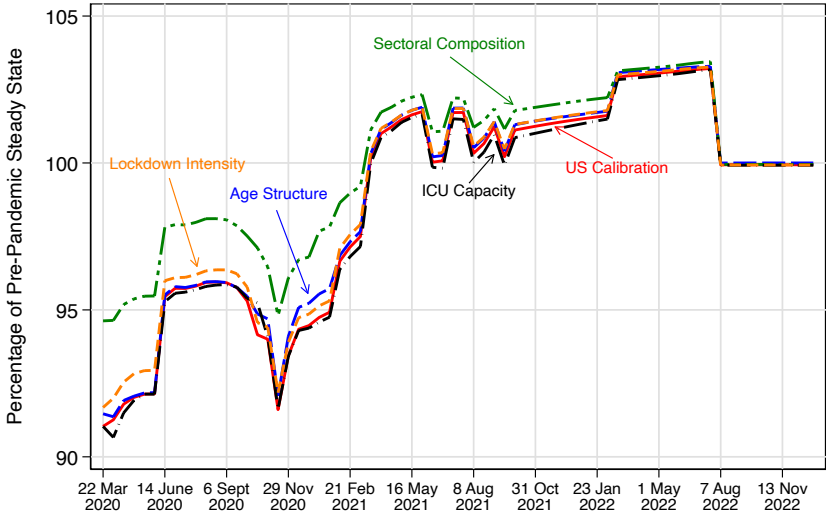
# Counterfactual Deaths: U.S. with Low-Income Economies' Features



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



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



# Conclusions So Far

- Macroeconomic outcomes worse during pandemic in emerging markets than in either advanced economies or low-income economies

- Quantitative results so far from macro-epidemiology model:

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

  - 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 comorbidities, school closing policies, vaccine rollouts ...