Deadly Debt Crises: COVID-19 in Emerging Markets

Cristina Arellano
Federal Reserve Bank of Minneapolis

Yan Bai
University of Rochester and NBER

Gabriel Mihalache
Stony Brook University

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COVID-19 in Emerging Markets

- Deadly epidemic with large human and economic cost
- Limited fiscal space brings more problems Hevia-Neumeyer (2020)
  - Multiple countries have defaulted on their government debt
    Argentina, Belize, Ecuador, Lebanon, Suriname, Zambia, Ethiopia
  - Spreads on government debt spiked and remained elevated
- IMF, World Bank, IDB have developed debt relief programs to support countries

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Health Crisis + Economic Crisis + Debt Crisis

Framework with Sovereign Default and an Epidemic

- Epidemic creates a health crisis with infections and fatalities (SIR model)
- Economy mitigates pandemic, borrows internationally, can default
  - Social distance measures saves lives but depress output
  - External borrowing useful to support consumption
  - Default risk limits fiscal capacity to support consumption and investment in lives

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- Analyze debt relief policies: support consumption, prevent defaults, save lives

Debt relief policies extremely useful

Our Findings

- Epidemic generates debt crisis with defaults and elevated spreads (3 years)
- Sizable welfare losses from triple crisis: loss of 0.76% in consumption equivalence

- Better financial markets improve health and economic outcomes
- Large social benefit from debt relief (voluntary restructurings and default-free loans)

Literature

- Macro + COVID-19:
  Atkeson (2020), Eichenbaum-Rebelo-Trabandt (2020), *Alvarez-Argente-Lippi (2020)*, Glover et al. (2020), Acemoglu et al. (2020), Cakmakli-Demiralp-KalemliOzcan (2020)

- Sovereign default:
  Arellano-MateosPlanas-RiosRull (2019), Espino-Kozlowski-Martin-Sanchez (2020)

- Debt relief:
  Bulow-Rogoff-Dornbusch (1988), Hatchondo-Martinez-SosaPadilla (2014, 2022), Hatchondo-Martinez-Onder (2017), Aguiar-Amador-Hopenhayn-Werning (2019)

An Integrated SIR and Partial Default Model

SIR Framework

Susceptible, Infected, and Recovered epidemiological framework:

$$\mu^S_{t+1} = \mu^S_t - \mu^x_t \qquad \text{(Susceptible)}$$

$$\mu^I_{t+1} = \left(1 - \pi^I\right) \cdot \mu^I_t + \mu^x_t \qquad \text{(Infected)}$$

$$\mu^x_t = \beta_t \cdot \mu^S_t \cdot \mu^I_t \qquad \text{(New Infections)}$$

$$\mu^D_{t+1} - \mu^D_t = \Pi_D\left(\mu^I_t\right) \cdot \mu^I_t = \phi_{D,t} \qquad \text{(New Fatalities)}$$

$$\mu^R_{t+1} - \mu^R_t = \left[\pi^I - \Pi_D\left(\mu^I_t\right)\right] \cdot \mu^I_t \qquad \text{(Newly Recovered)}$$

SIR Framework

Susceptible, Infected, and Recovered epidemiological framework:

$$\mu_{t+1}^S = \mu_t^S - \mu_t^x \qquad \text{(Susceptible)}$$

$$\mu_{t+1}^I = \left(1 - \pi^I\right) \cdot \mu_t^I + \mu_t^x \qquad \text{(Infected)}$$

$$\mu_t^x = \beta_t \cdot \mu_t^S \cdot \mu_t^I \qquad \text{(New Infections)}$$

$$\mu_{t+1}^D - \mu_t^D = \Pi_D\left(\mu_t^I\right) \cdot \mu_t^I = \phi_{D,t} \qquad \text{(New Fatalities)}$$

$$\mu_{t+1}^R - \mu_t^R = \left[\pi^I - \Pi_D\left(\mu_t^I\right)\right] \cdot \mu_t^I \qquad \text{(Newly Recovered)}$$

Social distancing (L_t), infectiousness (β_t), and the wedge (ψ_t):

$$\beta_t = \overline{\beta}\left(1 - \theta L_t\right)^2 \cdot \psi_t \qquad \mathcal{R}_t = \frac{\beta_t}{\pi^I} \cdot \frac{\mu_t^S}{1 - \mu_t^D}$$

Partial Default Framework

Country chooses intensity for default (d_t) and social distancing (L_t), new debt issuance (ℓ_t):

$$V_t(\mu_t, B_t) = \max_{\ell_t, d_t, L_t} \{u(c_t) - \chi\phi_{D,t} + \beta V_{t+1}(\mu_{t+1}, B_{t+1})\}$$

subject to

$$N_t c_t = Y_t - (1-d_t)(\delta + r)B_t + q_t(\mu_{t+1}, B_{t+1})\ell_t$$

$$B_{t+1} = [1 - \delta + \kappa(\delta + r)d_t]\, B_t + \ell_t$$

$$Y_t = \gamma(d_t)\, [N_t(1 - \theta_Y L_t)]^\alpha \qquad d_t \in [0,1] \qquad L_t \in [0, \overline{L}]$$

$$\mu_{t+1} \leftarrow \text{SIR}(\mu_t, L_t) \qquad N_t = \mu_t^S + \mu_t^I + \mu_t^R = 1 - \mu_t^D$$

Trade-offs:

- Default d_t: reduce debt service, arrears, productivity loss $\gamma(\cdot)$
- Social distancing L_t: output loss, reduce new infections

Partial Default Penalty Function

Output in period t:

$$Y_t = \gamma(d_t)\left[N_t(1-\theta_Y L_t)\right]^\alpha$$

Partial default penalty function:

$$\gamma\left(d_t\right) = \left[1-\gamma_0\left(d_t\right)^{\gamma_1}\right]\left[1-\gamma_2\,\mathbb{1}\left\{d_t > 0\right\}\right]$$

- Fixed cost: γ_2
- Convex cost: $\gamma_1 > 1$
- Share of productivity lost at $d_t = 1$, full default intensity: $\approx \gamma_0 + \gamma_2$

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$$d_t = \left[\frac{\delta + r}{\gamma_0\gamma_1(1-\gamma_2)} \cdot \frac{1-\kappa q_t}{(1-\theta_Y L_t)^\alpha} \cdot B_t\right]^{1/(\gamma_1 - 1)} \qquad \text{(Interior FOC)}$$

Bond Pricing

Competitive, risk-neutral lenders break even. Price the bond in period t

$$q_t\left(\mu_{t+1}\left(\mu_t, L_t\right), B_{t+1}\right) = \frac{1}{1+r}\left\{(\delta+r)(1-d_{t+1}) + \left[1-\delta+\kappa(\delta+r)d_{t+1}\right] q_{t+1}\left(\mu_{t+2}, B_{t+2}\right)\right\}$$

Price at t reflects future equilibrium policies

- $d_{t+1} = d_{t+1}\left(\mu_{t+1}, B_{t+1}\right)$
- $L_{t+1} = L_{t+1}\left(\mu_{t+1}, B_{t+1}\right)$
- $B_{t+2} = B_{t+2}\left(\mu_{t+1}, B_{t+1}\right)$

and the equilibrium evolution of the disease $\mu_{t+2} \leftarrow \text{SIR}\left(\mu_{t+1}, L_{t+1}\right)$.

Analytic Results in Two-Period Model

Simple model: Health crisis with default risk

Two-period setup

$$\max \; [u(c_0) - \chi\phi_{D,0}] + \beta\,[u(c_1) - \chi\phi_{D,1}(L_0)]$$

subject to SIR and budget constraints

$$N_0 c_0 = N_0(1 - L_0) + q_0(B_1)\,B_1,$$
$$N_1 c_1 + (1 - d_1)\,B_1 = [1 - \gamma(d_1)]N_1(1 - L_1)$$

Optimal behavior in period 1 (interior solution & convex $\gamma(\cdot)$)

$$L_1 = 0 \qquad\qquad \gamma'(d_1)N_1 = B_1$$

Proposition 1 *Epidemic generates default risk*

- Epidemic induces social distancing, which lower period 0 output
- Low period 0 output increases borrowing B_1 and thus default

Simple model: Health crisis with default risk

$$u'(c_0) = \beta\chi\left(-\frac{\partial\phi_{D,1}(L_0)}{\partial L_0}\right) \qquad \text{(MB=MC for } L_0\text{)}$$

Consumption is share of wealth (lockdown L_0, default loss $\gamma(d_1)$, domestic rate $r^d(B_1)$ reflecting default)

$$c_0 = \frac{1}{1+\frac{1}{1+r}\left[\beta\left(1+r^d(B_1)\right)\right]^{1/\sigma}}\left((1-L_0)+\frac{1}{1+r}[1-\gamma(d_1)]\right)$$

Proposition 2 *Deaths are higher with default risk than in an economy with perfect financial markets*

- Future default lowers life-time income, increases borrowing rate $\Rightarrow$ lower c_0
- Low consumption increases MC of lockdown, which reduces its intensity (default risk leads to *underinvestment* in lives)

Quantitative Analysis

Quantitative Analysis

Parametrization and baseline economy

- Use Latin American data (IHME) on fatalities and social distancing, good fit
  (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay)

The role of financial conditions

- Better financial markets improved epidemic outcomes

Debt relief programs have large social value

- Room for voluntary restructurings between country and private lenders
- Intl financial assistance leads to better mitigation policies and reduced debt crisis

Model Parameters, External

Parameters Set Externally	Value	Comment
Preferences		
Intertemporal elasticity $1/\sigma$	0.5	Standard value
Discounting β	$\sqrt[52]{0.98}$	EM domestic real rate, 2%
Epidemiological		
Infection length π^I	0.721	Mean recovery 6 days, CDC estimates
Soc distancing effectiveness θ	0.5	Mossong et al. (2008)
Debt and Default		
Risk free rate r	1%	International real rate, annualized
Debt duration δ	0.0037	Macaulay duration 5 years
Recovery factor κ	0.54	Cruces-Trebesch (2013)

- Use IHME data and CDC estimates to set external and internal parameters
- Pre-pandemic debt duration and recovery rates estimates
- Effectiveness of social distancing: infections at work & school versus at home

Model Parameters, Internal

Parameters Set Internally	Value	Moment
Fatalities		
Value of statistical life χ	3500	Cumulative deaths, 2020
Fatalities, baseline π_0^D	0.0085	Case fatality rate
Fatalities, congestion π_1^D	0.08	Cumulative deaths, 2021
Default and Social Distancing Costs		
Linear γ_0	0.04	Debt increase, 2020
Exponent γ_1	1.62	Consumption growth, 2020
Fixed γ_2	0.0178	Initial debt level
Output cost of social distancing θ_Y	0.8	Peak spread
Epidemiological		
Asymptotic β^{end}	1.35	Social distancing, 2020
Decay rate ρ	0.99	Social distancing, 2021

- χ in range of VSL estimates from LatAm, 10 years residual life
- Data fatalities and CFR discipline $\Pi_D(\cdot)$, debt and consumption default costs
- Eventual disease infectiousness impacts overall social distancing effort

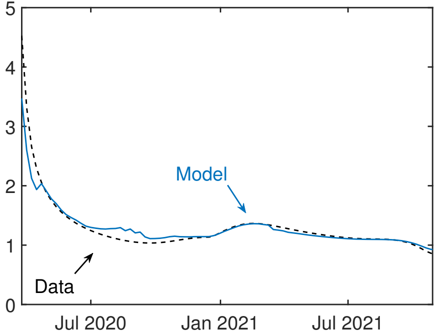
Recovering the Wedge in the Data

Starting with data on new fatalities and social distancing, $\left\{\phi_{D,t}^{\text{data}}, L_t^{\text{data}}\right\}_t$ from IHME:

1. Given parameters, invert $\phi_{D,t}^{\text{data}} = \Pi_D\left(\mu_t^{I,\text{data}}\right)$ to recover the infected $\left\{\mu_t^{I,\text{data}}\right\}_t$
2. Given initial condition, recover stock of susceptible each week, $\left\{\mu_t^{S,\text{data}}\right\}_t$
3. Use new infections to recover infectiousness, $\left\{\beta_t^{\text{data}}\right\}_t$
4. Purge impact of social distancing: $\psi_t^{\text{data}} = \beta_t^{\text{data}} / (1 - \theta L_t^{\text{data}})^2$
5. Feed $\{\psi_t^{\text{data}}\}$ to model. Solve and compare with equilibrium infectiousness
    - Fixed point: model generates the same pattern of fatalities and social distancing

Model Fit

	Data	Model
Fatalities		
Case fatality rate	0.64	0.62
Cumulative, 2020	0.07	0.16
Cumulative, 2021	0.27	0.30
Social Distancing		
Mean, 2020	0.32	0.25
Mean, 2021	0.12	0.05
Max, 2020	0.68	0.74
Max, 2021	0.30	0.23
Debt, Consumption, and Spreads		
Initial debt level	60.0	60.0
Debt increase, 2020	8.0	8.4
Consumption growth, 2020	−7.0	−7.2
Peak spread	5.50	5.61
Mean spread, 2020	2.24	4.63



Infectiousness Wedge ($\bar{\beta}\psi_t$)

- Model matches CFR and deaths through 2021
- Social distancing in 2020 and 2021
- Debt and spreads increase to support consumption

The Role of Financial Markets

Perfect Financial Markets

Eliminate default option and replace b.c. by time-zero, lifetime-income constraint:

$$\sum_{t=0}^{\infty} \frac{1}{1+r} N_t c_t = -B_0 + \sum_{t=0}^{\infty} \frac{1}{1+r} \left[N_t(1-\theta L_t)\right]^{\alpha}$$

Keep same β and r, for comparable welfare:

$$\frac{u'(c_t)}{u'(c_{t+1})} = \beta(1+r) < 1$$

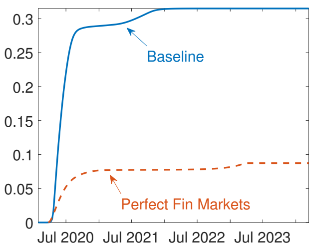
Pandemic has *level* effect on consumption path. Report relative to pre-pandemic trend.

Epidemic Outcomes and Fin Markets

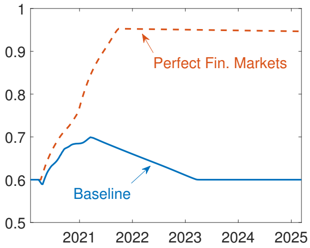
	Baseline	Perfect Fin. Markets
Health Crisis		
Fatalities (% pop)	0.315	0.087
Length (months)	32.0	40.5
Debt Crisis		
Peak debt increase	9.9	35.3
Peak spread	5.6	—
Length (months)	39.0	—
Economic Crisis		
Cumulative output loss	32.4	35.8
...from social distancing	16.6	35.8
...from default cost	16.7	—
Length (months)	39.0	19.3
Welfare Loss (% output)		
Country	37.4	27.2
Lenders	12.9	—

- 72% fewer fatalities with perfect fin markets, more prolonged fight against the disease
- Extensive use of debt to smooth consumption, larger loss of income from social distancing
- Large welfare cost of epidemic, reported as PV of Consumption Equivalent measure, as % of yearly output. Default risk worsens cost of epidemic

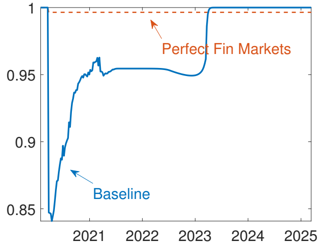
Financial Markets



Deceased



Debt



Consumption

- Deadlier epidemic with default risk
- Ample access to credit enables
  - aggressive mitigation of disease
  - consumption smoothing

International Financial Assistance

The Value of Outstanding Debt & Intl Assistance

Market unit value of outstanding debt upon the unexpected *outbreak* of the epidemic:

$$\tilde{q}\left(\mu_0, B_0\right) = (1 - d_0(\mu_0, B_0))(\delta + r) + \left[1 - \delta + \kappa(\delta + r)d_0(\mu_0, B_0)\right] q_0(\mu_1, B_1)$$

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Voluntary Restructuring: $\tilde{q}(\mu_0, B_0)B_0$ decreasing in B_0 (room for vol restructuring) if the resulting equilibrium default path $\{d_0, d_1, \ldots\}$ and debt $\{B_1, B_2, \ldots\}$ imply a lower haircut.

$$\tilde{q}\left(\mu_0, B_0^{\text{high}}\right) B_0^{\text{high}} = \tilde{q}\left(\mu_0, B_0^{\text{low}}\right) B_0^{\text{low}}$$

Lenders are indifferent, country is better off.

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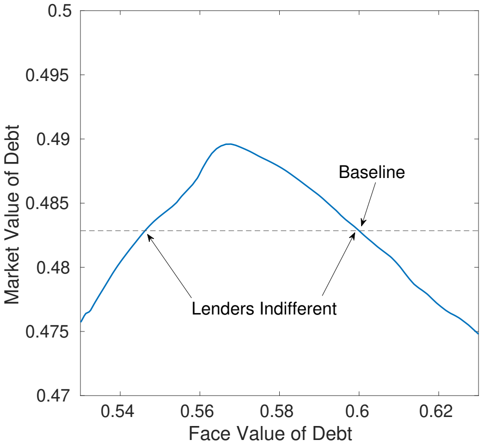
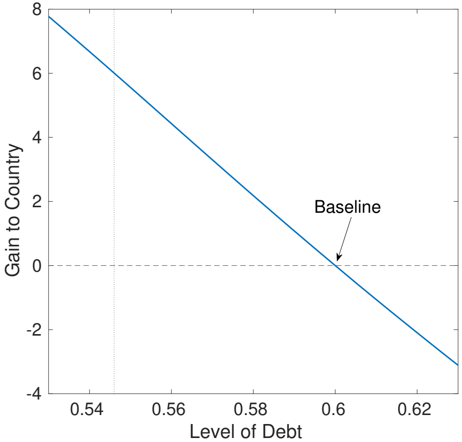
International Assistance Loan: Receive lump-sum assistance now (at $t = 0$), worth 10% of annual output, start repaying with a perpetuity 3 years later. Assume no default on this official loan. *PV of zero to official lender.*

Voluntary Restructuring



Value to Lenders of Outstanding Debt Upon Epidemic Outbreak ($\tilde{q}(\mu_0, B_0) \cdot B_0$)



Gain to Country from Debt Reduction

Debt Relief & Intl Financial Assistance

	Loan Program			Voluntary
	50%	**60%**	70%	Restructuring
Country welfare gain (% output)	6.2	7.5	7.2	6.2
Debt crisis: length reduction (months)	0.8	22.0	33.0	13.0
Debt crisis: reduction in spread (%)	0.9	3.6	7.3	2.4
Health crisis: deaths prevented (% deaths)	18.9	10.6	0.1	3.4
Lenders gain (% output)	1.7	7.6	12.4	0.0

- Loan: 10% of output now, repay with default-free perpetuity starting in 3 years
- Use of loan funds varies w/ debt level: fight health crisis vs debt crisis?
- Large gains to country from loan or vol restructuring with no (extra) costs to foreigners