Deadly Debt Crises: COVID-19 in Emerging Markets

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Motivation: COVID-19 in Latin America

- Deadly epidemic with large human cost: 500,000+ official deaths as of December
- Depressed economic activity: industrial production collapsed 30%, large output contractions
- Limited fiscal space brings more problems (Hevia-Neumeyer 2020)
  - Argentina, Ecuador, Belize defaulted on their government debt
  - Spreads on government debt spiked up and remain 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 (SIR model)
  - Generates paths for infections and fatalities
- Economy lock downs, borrows internationally, can default
  - Lockdowns (social distance measures) saves lives but depress output
  - Borrowing useful to support consumption
  - Default risk limits fiscal capacity to support consumption and investment in lives
- Epidemic generates debt crisis: Low output and limits in fiscal capacity $\rightarrow$ defaults and high spreads
- Default risk makes lockdowns more costly: Lack of fiscal capacity $\rightarrow$ more fatalities

Framework produces combined health + economic + debt crises

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Framework produces combined health + economic + debt crises

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

Debt relief policies super useful

Our Findings

- Epidemic generates long debt crisis with defaults and elevated spreads (4 years)
- Lockdowns for 1 year saves lives (fatalities reduced from 1.5% to 0.16%)
- Welfare loss of 0.6% in consumption equivalence
- Better financial markets improve epidemic and economic activity
  - Can use borrowing to support consumption, avoid default costs
  - Allows better mitigation that saves lives
- Large social benefits from debt relief
  - Voluntary restructurings possible: reduce debt about 9%
  - Default free loan: 10% benefits the country by 0.15% in consumption equivalence

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), growing literature
- Sovereign default: Arellano-MateosPlanas-RiosRull (2019), Espino-Kozlowski-Martin-Sanchez (2020), others
- Debt relief: Bulow-Rogoff-Dornbusch (1988), Aguiar-Amador-Hopenhayn-Werning (2019)

Model

- Small open economy with preferences over consumption and life
- Economy is hit by unexpected epidemic
  - Dynamics follow a epidemiological SIR model with lockdowns
- Government borrows internationally, can default on its debt, decides on lockdowns
  - Both default and lockdowns are of endogenous intensity and length

Preferences, Technology, and Epidemic

- Preferences over consumption c_t and life — ϕ_t^D are fatalities, χ value of life

$$v_0 = \sum_{t=0}^{\infty} \beta^t \left(u(c_t) - \chi \phi_t^D \right)$$

- Output depends on productivity z_t, lockdowns L_t, and population N_t:

$$Y_t = z_t((1 - L_t)N_t)^{\alpha}$$

- Epidemic: Population transits from susceptible, to infected, to recovered or deceased $\mu^S \to \mu^I \to [\mu^R \text{ or } \mu^D]$

- Key newly infected μ_t^x: $\mu^S \to \mu^I$

$$\mu_t^x = \tilde{\mathcal{R}}_0 \left((1 - \theta L_t)\mu_t^I \right) \left((1 - \theta L_t)\mu_t^S \right)$$

- Fatalities depend on infections $\phi_t^D = \phi^D(\mu_t^I)$

Lockdowns reduce infections, improve epidemic outcome, but depress output

Government Debt and Default

Based on Arellano-MateosPlanas-RiosRull (2019)

- Use international debt operations to support consumption

$$N_t c_t + (1 - d_t) B_t = Y_t + q_t \ell_t$$

- Borrows at price q_t and can default on its debt B_t with intensity d_t
- Default leads to loss of productivity proportional to intensity $z_t = z(d_t)$
- Fraction κ of defaulted debt accumulates and increases future debt obligations

$$B_{t+1} = \ell_t + \kappa \, d_t \, B_t$$

- Risk neutral lenders discount at world rate r and break even in expected value

$$q_t = \frac{1}{1+r} \left[(1 - d_{t+1}) + d_{t+1} \, \kappa \, q_{t+1} \right]$$

More default with high debt, low output, and low bond price (due to low repayment prospects)

Government Problem

- Integrated problem with state variables: epidemic groups $\mu_t = (\mu_t^S, \mu_t^I, \mu_t^D)$ and debt B_t
- Government chooses borrowing B_{t+1}, default d_t, and lockdowns L_t

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

- subject to the epidemic dynamics which determine $\mu_{t+1}(\mu_t, L_t)$ and resource constraint

$$N_t c_t + (1 - d_t) B_t = z_t((1 - L_t) N_t)^\alpha + q_t(B_{t+1}, \mu_{t+1})(B_{t+1} - \kappa d_t B_t),$$

- bond price depends on epidemic $q_t(B_{t+1}, \mu_{t+1})$

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- bond price depends on epidemic $q_t(B_{t+1}, \mu_{t+1})$

Epidemic generates debt crises: low output and low repayment prospects → defaults

Debt crises can increase death toll: makes lockdowns more costly

Dynamic Program

Government problem with state $\mu_t = (\mu_t^S, \mu_t^I, \mu_t^D)$ and debt B_t

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

subject to population $N_t = (1 - \mu_t^D)$

resource constraint
$$N_t c_t + (1 - d_t)B_t = z_t(N_t(1 - L_t))^\alpha + q_t(B_{t+1}, \mu_{t+1})(B_{t+1} - \kappa d_t B_t)$$

SIR dynamics
$$\mu_t^x = \tilde{\mathcal{R}}_0(1 - \theta L_t)\mu_t^I(1 - \theta L_t)\mu_t^S$$
$$\mu_{t+1}^I = \pi_I \mu_t^I + \mu_t^x$$
$$\mu_{t+1}^S = \mu_t^S - \mu_t^x.$$
$$\mu_{t+1}^D = \mu_t^D + \pi_D(\mu_t^I)\mu_t^I$$

bond price function:
$$q_t(B_{t+1}, \mu_{t+1}(\mu_t, L_t)) = \frac{1}{1+r}\left\{(1 - \mathbf{d_{t+1}}) + \kappa \mathbf{d_{t+1}} q_{t+1}(\mathbf{B_{t+2}}, \boldsymbol{\mu_{t+2}})\right\}.$$

Simple model: Health and debt crises

- Our model features a two way feedback loop between default risk and the epidemic
- Simplified 2 period model to make two points
- Epidemic increases default risk:
  - Lockdowns during the epidemic increases borrowing incentives to support consumption
  - More borrowing leads to more default
- Default risk makes epidemic worse:
  - Inability to support consumption reduces lockdown incentives
  - Less mitigation leads to more deaths

Simple model: Set up

- Consider a 2 period model preferences over consumption and life

$$u(c_0) + \beta[u(c_1) - \chi\phi^D(\mu_1^I)]$$

- Consumption depends on output, borrowing, and default

$$\begin{aligned} c_0 &= y_0 + q(B_1)B_1 \\ c_1 &= y_1 - (1 - d_1)B_1 \end{aligned}$$

- Bond price depends on default $q(B_1) = \frac{1-d(B_1)}{1+r}$
- Deaths depend on infections, which can be altered with lockdowns L_0

$$\mu_1^I = \mathcal{R}_0(1 - \theta L_0)^2 \mu_0^I \mu_0^S$$

- Output in pd 0 decreases with lockdowns $y_0 = z(1 - L_0)$, in pd 1 decreases with default $y_1 = z\gamma(d_1)$

Simple model: Perfect financial markets

- No default implies that bond price is the inverse of risk free rate
- Lifetime budget constraint, lockdowns reduce lifetime income

$$c_0 + \frac{c_1}{1+r} = z(1-L_0) + \frac{z}{1+r}$$

- Optimality conditions

$$u'(c_0) = \beta(1+r)u'(c_1), \qquad u'(c_0)z = \beta\chi\left(-\frac{\partial\phi^D}{\partial L_0}\right)$$

- Consumption path based on permanent income, with CRRA utility

$$c_0^{eff} = \frac{1}{1+\frac{1}{1+r}[\beta(1+r)]^{1/\sigma}}\left(z(1-L_0) + \frac{z}{1+r}\right)$$

- Efficient lockdown solves, akin to an investment decision

$$\left(\frac{z(1-L_0^{eff}) + \frac{1}{1+r}z}{1+\frac{1}{1+r}[\beta(1+r)]^{1/\sigma}}\right)^{-\sigma} z = \beta\chi\left(-\frac{\partial\phi^D}{\partial L_0^{eff}}\right)$$

- Cost of lockdowns is c_0, affected by lockdowns through loss in permanent income

Simple model: Default risk

- Default increases with borrowing
$$-\gamma'(d_1) = B_1$$
- Borrowing rates higher with default risk
- Consumption path depends on domestic interest rate which increases with default
$$u'(c_0) = \beta(1 + r^c(B_1))u'(c_1)$$
- Domestic rate depends on elasticity of bond price $(1 + r^c(B)) = (1 + r)/(1 - \partial \log q(B_1)/\partial \log B_1)$
- Consumption c_0 lower with default risk – higher domestic rate and lower permanent income
$$c_0 = \frac{1}{1 + \frac{1}{1+r}[\beta(1 + r^c(B_1))]^{1/\sigma}} \left(z(1 - L_0) + \frac{z\gamma(d_1)}{1 + r} \right).$$
- Default risk restricts consumption c_0, which increases cost of lockdown
$$u'(c_0) = \beta\chi \left(-\frac{\partial \phi^D}{\partial L_0} \right)$$
- Default risk leads to underinvestment

Simple model: Health crisis with default risk

Proposition 1 *(Epidemic generates default risk) The default intensity d_1 is higher with the epidemic*

- Epidemic induces lockdowns, which lower pd 1 output
- Low pd 1 output increases borrowing which rises default risk

Proposition 2 *(Default risk worsens epidemic) Deaths are higher with default risk*

- Pd 0 consumption is lower with default risk
- Low consumption increases marginal cost of lockdown, which reduces its intensity
- Fatalities increase with less intense lockdowns

Quantitative Analysis

Parametrization and baseline economy

- Use Latin American data on fatalities and mobility
- Time paths: fatalities, lockdowns, spreads, debt, consumption, defaults

The role of financial conditions

- With perfect financial markets: improved epidemic outcomes, no debt crisis
- Financial autarky: worse epidemic

Debt relief programs have large social value

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

Parameter Settings

Weekly model, some parameters from literature and others in moment-matching to Latin America 2020

- Epidemic: Disease length π_I to 18 days; Lockdown effec. $\theta = 0.5$ (Mossong 2008), value of life from EM (Viscusi-Masterman) 10 years residual life
- Fatalities increases with infected + congestion in the health care system $\pi_D(\mu_t^I) = (\pi_D^0 + \pi_D^1 \mu_t^I)\mu_t^I$, with $\pi_D^0 = 0.005$ from Korean data and literature
- Reproduction number allowed to vary, higher in the beginning $\mathcal{R}_t = \mathcal{R}_0\, \rho^t + \mathcal{R}_\infty(1-\rho^t)$, with $\mathcal{R}_0 = 2.6$ from Diamond Princess estimates
- Default: Cost increasing in default intensity, parameters from Arellano-MateosPlanas-RiosRull

$$z(d) = [1 - \gamma_0 d^{\gamma_1}](1 - f\mathbb{1}_{d>0})$$

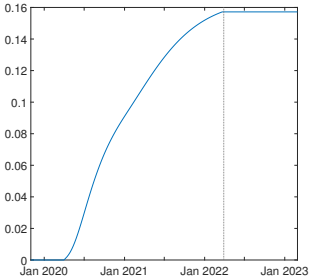
- Debt: maturity 5 years, mean recovery κ 54% (Trebesch-Cruces), $r = 1\%$ annual, β for 2% domestic real rate
- Preference $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ with $\sigma = 2$, labor share $\alpha = 0.67$
- Universal vaccine arrives in 2 years

Moment Matching and Model Fit

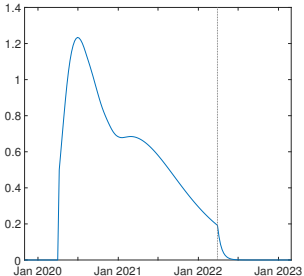
		Data	Model
Targeted moments			
Daily deaths (per 10K)			
Peak	0.047	0.047	
Timing of peak	Jul-20	Jul-20	
Lockdown intensity (%)			
Peak	48	41	
Timing of peak	Apr-20	Apr-20	
Initial debt-to-output	60%	60%	
Out of sample moments			
Average daily deaths	0.030	0.033	
Average lockdown intensity	21	25	
Spreads			
Peak	5.5	5.9	
Timing of peak	Apr-20	Apr-20	
Average	2.2	4.9	

- Use Latin American data for: Argentina, Brazil, Chile, Colombia, Ecuador, El Salvador, Dominican Republic, Mexico, Peru, Paraguay, Uruguay
- Choose 4 parameters: reproduction number $\{\mathcal{R}_\infty, \rho\}$, congestion for fatality rate π_D^1, fixed default cost f
- Fit 5 moments averaged across countries: peak and timing for: daily deaths and lockdown intensity (Google mobility-workplace), and government debt to output

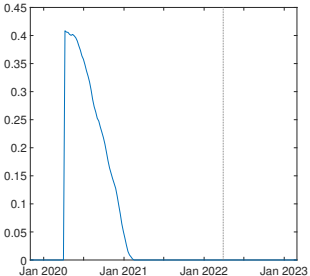
Time Paths: Epidemic and Lockdowns



Deceased



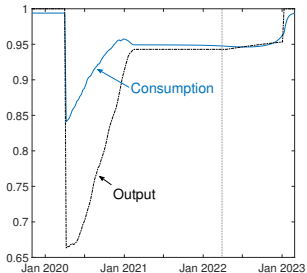
Infected



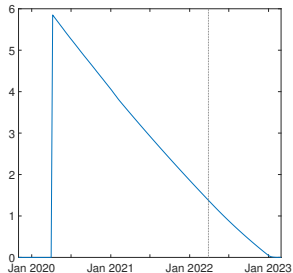
Lockdown

- Large health crisis, death toll 0.16% (840,000) and severe lockdowns
- Lockdowns: one year with 6 months of high intensity
- Absent lockdowns death toll would be 1.25% of population

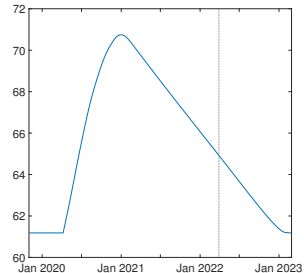
Time Paths: Debt Crisis



Consumption and Output



Spread



Debt

- Depressed consumption and output (15% drop first year)
- Spreads spike and remain elevated
- Debt increases with slow mean reversion

Epidemic Outcomes: Baseline

Health crisis	Deceased (% Pop)	0.16
	Peak daily deaths	0.047
Economic crisis	Lockdown	
	Length (months)	11
	Intensity, max (%)	41
	Output loss (%)	−29
	Debt Increase(%)	10
Debt crisis		
	Length episode (years)	4
	Spread, max (%)	5.9
Welfare losses (% output)	Country CE	−28
	Lender	−7

- Lockdown for 1 year, debt crisis for 4 years, output 29% lower from lockdowns and default costs
- Large welfare costs: for country 28% and for lenders 7%

$$\text{CE present value} = \frac{c^{\text{eq}}(\mu_0, B_0) - c^{\text{eq,pre}}(B_0)}{1-\beta} \qquad \text{Lenders' loss} = (\tilde{q}(\mu_0, B_0) - q^{\text{pre}}(B_0))B_0$$

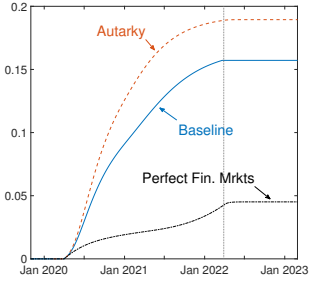
- CE puts all the value in goods $\frac{1}{1-\beta} u(c^{\text{eq}}(\mu_0, B_0)) = V_0(\mu_0, B_0)$
- Lenders loss reflects drop in bond price with epidemic

Epidemic Outcomes and Financial Markets

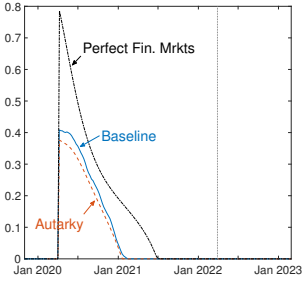
		Baseline with default	Perfect financial mkts	Financial autarky
Health crisis	Deceased (% Pop)	0.16	0.05	0.19
	Peak daily deaths	0.04	0.01	0.06
Economic crisis	Lockdown			
	Length (months)	11	16	10
	Output loss (%)	−29	−27	−13
	Debt Increase(%)	15	70	0
Debt crisis				
	Length episode (years)	9	–	–
Welfare losses (% output)	Country CE	−28	−19	−30
	Lender	−7	–	–

- Perfect financial markets: Cut deaths by 71%, no debt crisis boosts output, epidemic less costly
- Financial autarky: More deaths 21%, epidemic more costly
- Default risk makes epidemic about 50% more costly

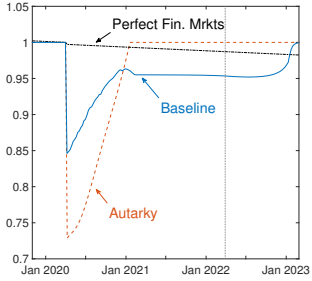
Financial Markets Matters



Deceased



Lockdown



Consumption

- Default risk makes epidemic more deadly
- Ample access to credit enable aggressive mitigation of the disease

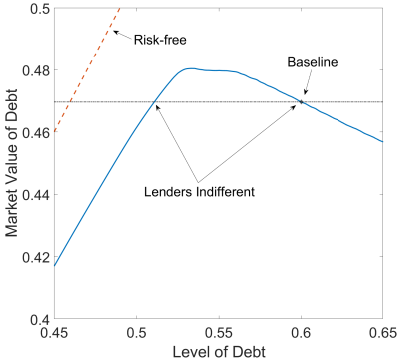
Debt Relief Counterfactuals

- International financial assistance programs can be useful policy tools
- IMF, the World Bank, and others have rapidly implemented debt relief programs to support countries
- Programs consist of new loans and restructuring guidance
  (Catastrophe and Containment Relief Trust, the Rapid Credit Facility, and Stand-By Credit Facilities, Debt Service Suspension Initiative)
- Use our model to conduct two counterfactuals
  - Voluntary restructuring between country and private lenders
  - Loan programs: Default-free long term loan from financial assistance entity (0 NPV)
- Debt relief programs alter choices for lockdowns, default, consumption, which change epidemic outcomes

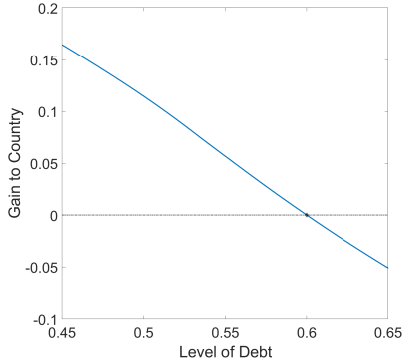
Debt Relief Programs: Voluntary Restructuring

- Value of debt to lenders is $\tilde{q}(\mu_0, B_0)B_0$
- Price of debt upon the outset of the epidemic $\tilde{q}(\mu_0, B_0)$ decreases with B_0
- Does value $\tilde{q}(\mu_0, B_0)B_0$ decreases with B_0?

Debt Relief Programs: Voluntary Restructuring



Value to Lenders of Outstanding Debt



Gain to Country from Debt Reduction

- Country and lenders gain from voluntary restructuring
- Large epidemic shock puts country at "wrong" side of the Laffer Curve
- Reduce debt to about 0.51: lenders indifferent, country gains 10%

Debt Relief: Loan from Financial Assistance

- Loan: financial assistance long-term default-free loan of 10% of output
- Country gets $\tilde{F}$ and pays F in perpetuity
- Financial assistance breaks even $\tilde{F} = rF$

	Loan Program			Voluntary Restructuring
	50% Debt	60% Debt (baseline)	70% Debt	60% to 51%
Country welfare gains (% output)	5.4	7.5	7.4	10.6
Debt crisis: length reduction (years)	0.2	2	3	3
Debt crisis: max spread reduction (%)	0.4	4.2	7.5	4.1
Health crisis: deaths prevented (% deaths)	11.5	2.1	1.5	1.1
Lenders gains (% output)	0.4	4.7	6.6	0

- Gains from programs: better mitigation, improve debt crises, relax fin. frictions
- Loan program generates 7.5% gain to country and 4.7% to lenders in baseline

Conclusion

- Pandemic creates challenge for emerging markets with default risk $\Rightarrow$ health crisis + economic crisis + debt crisis
- Financial markets matter for epidemic outcomes
- Debt relief programs large social value