Default and Interest Rate Shocks: Renegotiation Matters

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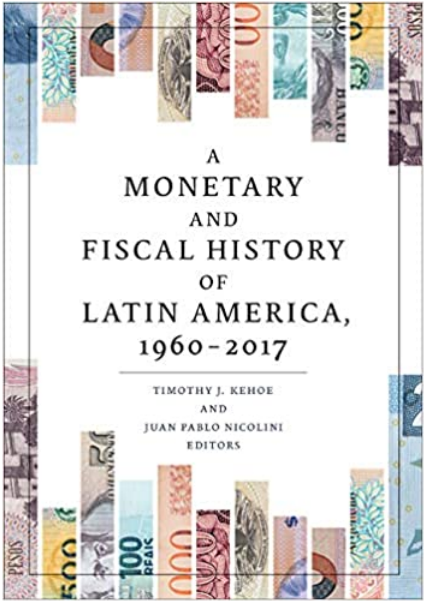
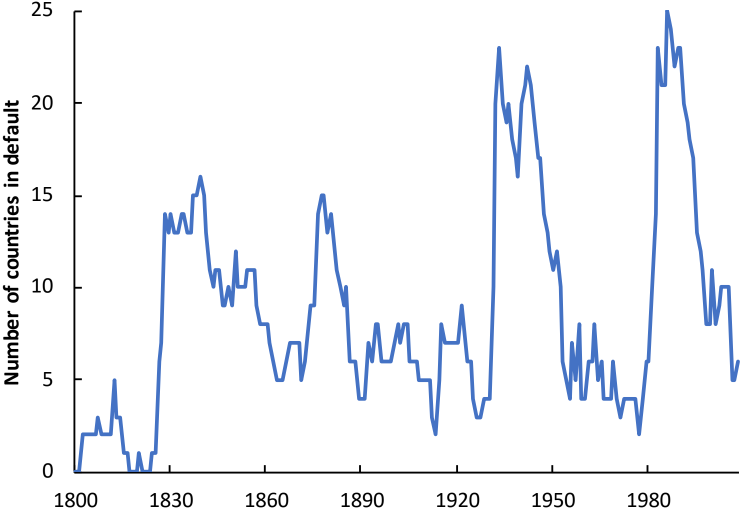
March 2023

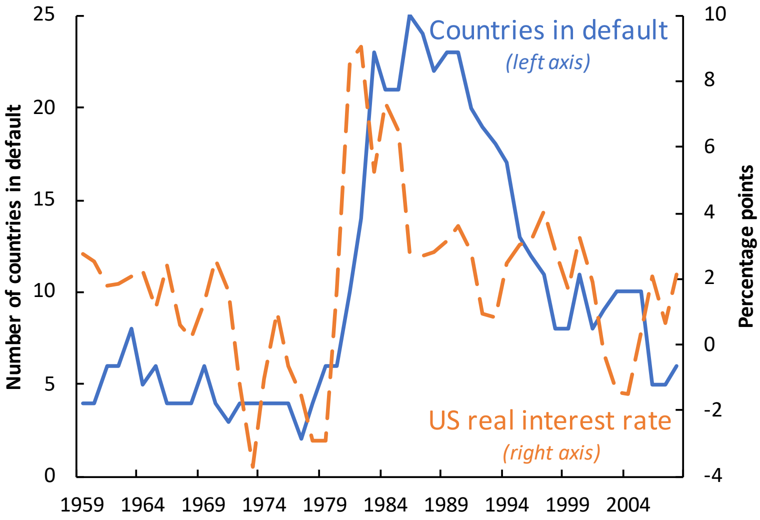
A Monetary and Fiscal History of Latin America, 1960-2017



Default status over time



Default status and US real interest rate



This paper

- Volcker Shock could have caused defaults in 1980s
- Sovereign default model with renegotiation of debt level
- World interest rates and default incentives
  - Standard mechanism: higher $r \implies$ higher borrowing costs
  - Our mechanism: higher $r \implies$ higher expected haircut
- Quantitative results:
  - Standard mechanism is negligible
    - 3% of defaults triggered by interest-rate hikes
  - Our mechanism is large
    - 10% of defaults triggered by interest-rate hikes

Related literature

- **Sovereign default model**
  - Aguiar and Gopinath (2006), Arellano (2008)
- **Long-term debt**
  - Hatchondo and Martinez (2009), Chatterjee and Eyigungor (2012), Arellano and Ramanarayanan (2012)
- **Debt renegotiation**
  - Yue (2010), Hatchondo, Martinez, and Sosa-Padilla (2014)
- **Varying risk free interest rates**
  - Guimaraes (2011), Johri, Khan, and Sosa-Padilla (2016), Tourre (2017)

Model, environment

- Small open economy, stochastic income y_t

$$\log y_t = \rho \log y_{t-1} + \epsilon_t,\ \epsilon_t \sim N\left(0, \sigma_\epsilon^2\right)$$

- Volcker Shock: $r_t \in \left\{r^H, r^L\right\}$ follows Markov chain: transition matrix $\pi_{i,j}$, where $i, j \in \{H, L\}$

- Preferences for consumption each period $u\left(c_t\right) = \frac{c_t^{1-\sigma} - 1}{1-\sigma}$

- Long-term bonds b_t, price q_t, mature at rate γ, law of motion:

$$b_{t+1} = (1 - \gamma)\, b_t + i_t$$

- State of the economy is $\left(b_t, y_t, r_t, d_{t-1}\right)$

- Measure 1 of identical risk-neutral competitive lenders with deep pockets

Model, environment

- At the beginning of each period the sovereign can default:
  - Payment γb_t is not made
  - Income is $h(y_t) = y_t - \max\{0, \phi_0 y_t + \phi_1 y_t^2\}$, $\phi_0 < 0 < \phi_1$
  - An opportunity to renegotiate arrives with probability θ
- When an opportunity to renegotiate arrives:
  - Face value of debt changes to b_t^R
  - Sovereign gains access to financial markets, can borrow to pay γb_t^R
  - Each of the identical lenders gets $\gamma b_t^R + (1-\gamma) q_t b_t^R$
  - b_t^R is agreed upon through Nash bargaining

Model, sovereign problem

- If the sovereign paid its debt in the previous period:

$$V(b, y, r, 0) = \max_{d \in \{0,1\}} \left\{ (1-d)\, V^P(b, y, r) + d V^D(y, r) \right\}$$

where the value of repaying is:

$$V^P(b, y, r) = \max_{b^P} \left\{ u(c) + \beta \mathbb{E}\left[V\left(b^P, y', r'\right) \right] \right\}$$

$$s.t. \quad c + \gamma b = y + q\left(b^P, y, r\right) \left[b^P - (1-\gamma)\, b \right]$$

and the value of defaulting is:

$$V^D(y, r) = u(h(y)) + \beta \mathbb{E}\left[\theta V^P\left(b^R(y', r'), y', r' \right) + (1-\theta)\, V^D(y', r') \right]$$

Model, renegotiation one-period debt

Renegotiated debt b^R is the solution to the Nash Bargaining problem:

$$b^R(y,r) = \arg\max_{\tilde{b}} \left\{ S^{LEN}\left(\tilde{b}, y, r\right)^{\alpha} S^{SOV}\left(\tilde{b}, y, r\right)^{1-\alpha} \right\}$$

$$s.t. \quad S^{LEN}\left(\tilde{b}, y, r\right) = \left[\gamma + (1-\gamma)\, q\left(b^P\left(\tilde{b}, y, r\right), y, r\right)\right]\tilde{b} - Q(y,r) \geq 0$$

$$S^{SOV}\left(\tilde{b}, y, r\right) = V^P\left(\tilde{b}, y, r\right) - V^D(y,r) \geq 0$$

where Q is the lenders' outside option of waiting for better terms:

$$Q(y,r) = \frac{\theta}{1+r}\mathbb{E}\left[\left(\gamma + (1-\gamma)\, q\left(b', y, r\right)\right) b^R\left(y', r'\right)\right] + \frac{1-\theta}{1+r}\mathbb{E}\left[Q\left(y', r'\right)\right]$$

where $b' = b^P\left(b^R\left(y', r'\right), y', r'\right)$

Model, equilibrium

An equilibrium is value and policy functions, a bond price schedule q, an outside option Q, and a renegotiation rule b^R such that:

1. Given q, Q, and b^R, the value and policy functions solve the sovereign's problem
2. Given q, Q, and the value and policy functions, b^R solves the bargaining problem
3. The bonds price schedule is consistent with zero profits in expectation

$$q\left(b',y,r\right)b' = \frac{\mathbb{E}\left[\left\{1-d\left(b',y',r'\right)\right\}\left\{\left(\gamma+\left(1-\gamma\right)q\left(b'',y',r'\right)\right)\right\}\right]b'}{1+r} + \frac{\mathbb{E}\left[d\left(b',y',r'\right)Q\left(y',r'\right)\right]}{1+r}$$

where $b'' = b^P\left(b',y',r'\right)$

Characterization of the renegotiation game

- From the F.O.C. of the bargaining problem we get

$$\alpha \frac{S^{SOV}\left(b^R, y, r\right)}{u'\left(y - \left(\gamma + (1-\gamma)\, q\left(b', y, r\right)\right) b^R + q\left(b', y, r\right) b'\right)} = (1-\alpha)\, S^{LEN}\left(b^R, y, r\right)$$

  where $b' = b^P\left(b^R, y, r\right)$

- If $\alpha = 0$ lenders have no bargaining power

$$S^{LEN}\left(b^R, y, r\right) = \left[\gamma + (1-\gamma)\, q\left(b', y, r\right)\right] b^R - Q\left(y, r\right) = 0$$

  which implies $b^R = 0$ (i.e. the standard model)

Characterization of the renegotiation game

- For the case of one-period debt ($\gamma = 1$):
  - Proposition: For $\alpha \in [0, 1]$ a solution b^R exists in every state and is unique
  - Proposition: For any $\alpha \in [0, 1]$ high risk-free interest rate implies:
    - borrowing is more expensive $q\left(b', y, r^H\right) \leq q\left(b', y, r^L\right)$
    - lenders' outside option is lower $Q\left(y, r^H\right) \leq Q\left(y, r^L\right)$
    - sovereign gets higher debt relief $b^R\left(y, r^H\right) \leq b^R\left(y, r^L\right)$

High interest rates and default incentives

The sovereign defaults if

$$V^P(b, y, r) < V^D(y, r)$$

Standard mechanism:

- $V^P(b, y, r^H) < V^P(y, r^L)$ (*higher borrowing costs*)

Our mechanism (with persistent r):

- $V^D(y, r^H) > V^D(y, r^L)$ (*lower expected renegotiated debt*)

High interest rates and borrowing costs

$$q\left(b',y,r\right) = \underbrace{\frac{1}{1+r}}_{\text{Standard mechanism}} \mathbb{E}\left[\left\{1-d\left(b',y',r'\right)\right\}\left\{\left(\gamma+(1-\gamma)\,q\left(b'',y',r'\right)\right)\right\}\right]$$

$$+ \underbrace{\frac{1}{1+r}}_{\text{Standard mechanism}} \mathbb{E}\left[\underbrace{d\left(b',y',r'\right)\frac{Q\left(y',r'\right)}{b'}}_{\text{Our mechanism}}\right]$$

Standard mechanism:

- Higher r reduces q because of higher discounting

Our mechanism (with persistent r):

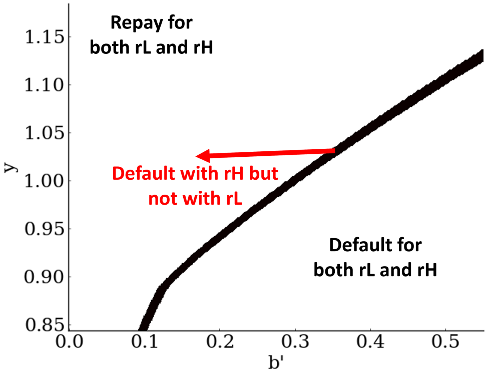
- Higher r' reduces expected $b^R \longrightarrow$ reduces value of holding defaulted debt Q

Calibration

Parameter		Value	Details
low r	r_L	1.2%	1955 - 1980
high r	r_H	6.2%	1981 - 1985
Pr(low to high r)	$\pi_{L,H}$	1%	Duration of 100 years
Pr(high to low r)	$\pi_{H,L}$	20%	Duration of 5 years
Pr(renegotiation)	θ	19.2%	5.2 years exclusion (Gelos et al. (2011))
risk aversion	σ	2	Standard
income process	ρ	0.705	AR(1) estimation
	σ_ϵ	0.040	annual data 1933-1983

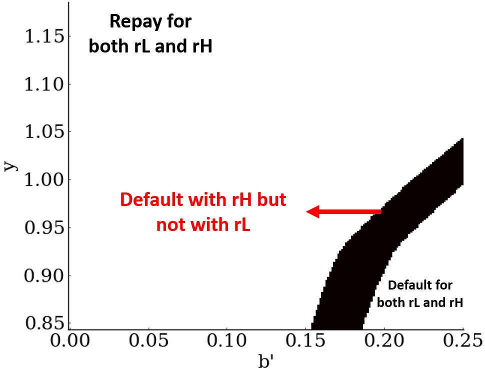
Calibration with no renegotiation

Parameter		Value	Moment	Data	Model
lenders' bargaining	α	**0.00**	average haircut	0.24	1.0
default cost	ϕ_0	-0.62	default probability	0.03	0.03
default cost	ϕ_1	0.69	average spreads	0.03	0.03
discount factor	β	0.77	debt-to-GDP ratio	0.19	0.19



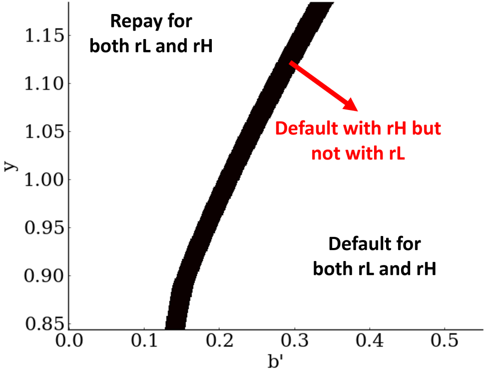
Same calibration with renegotiation

Parameter		Value	Moment	Data	Model
lenders' bargaining	α	**0.20**	average haircut	0.24	0.18
default cost	ϕ_0	-0.62	default probability	0.03	0.02
default cost	ϕ_1	0.69	average spreads	0.03	0.005
discount factor	β	0.77	debt-to-GDP ratio	0.19	0.56



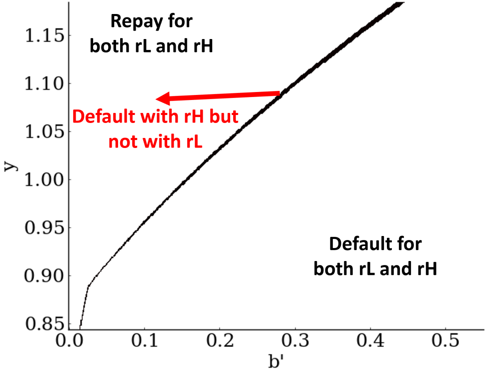
Recalibrate with renegotiation

Parameter		Value	Moment	Data	Model
lenders' bargaining	α	0.11	average haircut	0.24	0.24
default cost	ϕ_0	-0.20	default probability	0.03	0.03
default cost	ϕ_1	0.23	average spreads	0.03	0.02
discount factor	β	0.82	debt-to-GDP ratio	0.19	0.19



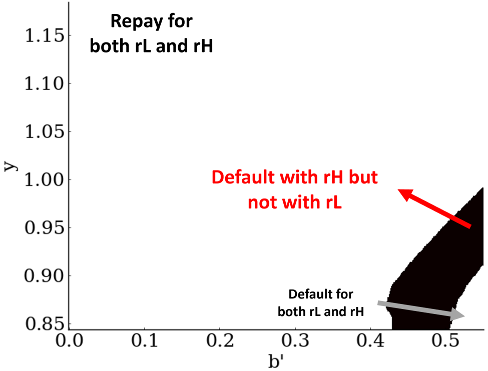
Calibration for no renegotiation, $\theta = 0.5$

Parameter		Value	Moment	Data	Model
lenders' bargaining	α	**0.00**	average haircut	0.24	1.0
default cost	ϕ_0	-0.62	default probability	0.03	0.06
default cost	ϕ_1	0.69	average spreads	0.03	0.08
discount factor	β	0.77	debt-to-GDP ratio	0.19	0.09



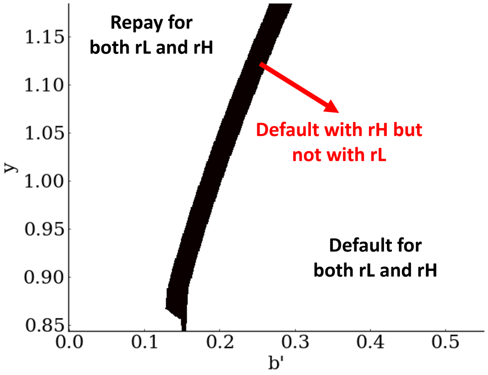
Same calibration with renegotiation, $\theta = 0.5$

Parameter		Value	Moment	Data	Model
lenders' bargaining	α	**0.20**	average haircut	0.24	0.09
default cost	ϕ_0	-0.62	default probability	0.03	0.04
default cost	ϕ_1	0.69	average spreads	0.03	0.005
discount factor	β	0.77	debt-to-GDP ratio	0.19	0.56



Calibration for renegotiation , $\theta = 0.5$

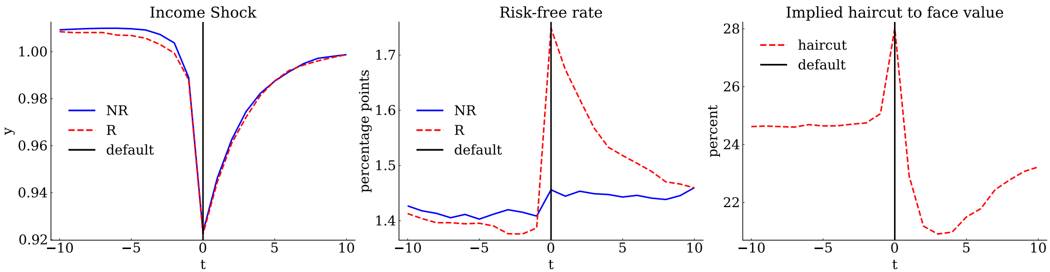
Parameter		Value	Moment	Data	Model
lenders' bargaining	α	0.11	average haircut	0.24	0.11
default cost	ϕ_0	-0.20	default probability	0.03	0.06
default cost	ϕ_1	0.23	average spreads	0.03	0.01
discount factor	β	0.82	debt-to-GDP ratio	0.19	0.17



Shocks that trigger default

- Without renegotiation: 3% of defaults happen with high r
- With renegotiation: 10% of defaults happen with high r

Average paths around default episodes



Volcker shocks and default

	No renegotiation (calibrated)	Fixed haircut 0.24 (calibrated)	Renegotiation (calibrated)
$Pr\left(\text{default} \middle\vert \text{Volcker shock}\right)$	0.06	0.13	0.22
$\frac{\text{defaults due to Volcker shock}}{\text{all default episodes}}$	0.02	0.05	0.09

Renegotiation failure in 1980s

- Renegotiation attempts every two years
- Renegotiation unsuccessful until Brady Plan in 1989/1990
- Potential explanation: US regulators did not allow banks to write down the debt

"Had these institutions been required to mark their sometimes substantial holdings of underwater debt to market or to increase loan-loss reserves to levels close to the expected losses on this debt (as measured by secondary market prices), then institutions such as Manufacturers Hanover, Bank of America, and perhaps Citicorp would have been insolvent." (Lewis William Seidman, *Full Faith and Credit*)

History of lost decade

"The entire Ford administration, including me, told the large banks that the process of recycling petrodollars to the less developed countries was beneficial, and perhaps a patriotic duty." (Lewis William Seidman, *Full Faith and Credit*)

- 1979 reinterpretation of law
  - Loans to a single borrower could not exceed 10 percent of bank's capital: different government agencies in foreign countries are different borrowers
- Regulation during 1980s
  - No reserves requirements for delinquent LDCs loans

Model, renegotiation (short-term debt) back

Renegotiated debt b^R is the solution to the Nash Bargaining problem:

$$
\begin{aligned}
b^R(y,r) &= \arg\max_{\tilde{b}} \left\{ S^{LEN}\left(\tilde{b},y,r\right)^{\alpha} S^{SOV}\left(\tilde{b},y,r\right)^{1-\alpha} \right\} \\
s.t. \quad & S^{LEN}\left(\tilde{b},y,r\right) = \tilde{b} - Q(y,r) \geq 0 \\
& S^{SOV}\left(\tilde{b},y,r\right) = V^P\left(\tilde{b},y,r\right) - V^D(y,r) \geq 0
\end{aligned}
$$

where Q is the lenders' outside option:

$$
Q(y,r) = \frac{\theta}{1+r}\mathbb{E}\left[b^R\left(y',r'\right)\right] + \frac{1-\theta}{1+r}\mathbb{E}\left[Q\left(y',r'\right)\right]
$$

Characterization of the renegotiation game

- From the F.O.C. of the bargaining problem we get

$$\alpha \frac{S^{SOV}\left(b^R, y, r\right)}{u'\left(y - b^R + q\left(b', y, r\right) b'\right)} = (1-\alpha) S^{LEN}\left(b^R, y, r\right)$$

  where $b' = b^P\left(b^R, y, r\right)$
- If $\alpha = 0$ then lenders have no bargaining power and we get

$$S^{LEN}\left(b^R, y, r\right) = b^R - Q\left(y, r\right) = 0$$

  which implies that $b^R = 0$ (i.e. the standard model)