Partial Sovereign Default

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Motivation

Emerging markets (and others) face frequent debt crises

- Sovereign default theory
  (Eaton-Gersovitz 1983, Aguiar-Gopinath 2006, Arellano 2008, Chatterjee-Eyigungor 2012)
  - Sovereign default more likely when fundamentals are weak and debt is large
  - Successful in replicating default events (Argentina 2001, Greece 2012)
  - Generates volatile and countercyclical interest rates spreads as in data
  - Volatile consumption: default risk limits risk sharing
- Existing sovereign default theory – Default leads to new start
  - Default leads to reduction in debt and during episodes no borrowing or repayment

Motivation: Sovereign Defaults in Data

In data sovereign default episodes have rich dynamics – Default leads to more default

- Defaults are partial, countries spend much time in default
  - Partial default on average 38%, 1/3 the time positive
- During default episodes:
  - Debt and partial default dynamics hump-shaped
  - Repayment and borrowing continue
  - On average 9 years long, but with many short default episodes
  - Debt not reduced but sizable haircuts

Today will focus on our more complete framework of sovereign partial default:

- Prior to the default, similar to existing theory
- New theory: adds partial default and dynamics during the default episode

Model Elements

- Sovereign chooses to which extent to pay debt due
- Partially defaulted debt not automatically written off, nor new borrowing ruled out
- Partial default is alternative to borrowing to inter-temporally transfer resources

  Partial default as portfolio choice
- Partial default amplifies debt crises
  - Defaulted payments accumulate and increase future indebtedness
  - Associated with resource costs and higher spreads on new borrowing

  Default leads to more default
- Default episodes end after sufficient output recovery and deleveraging
  - Tight bond prices gives incentive for deleveraging

Main Findings

This theory is capable of rationalizing patterns in data

- Properties of partial default: frequency, mean, and co-movements
  - Large partial defaults $\rightarrow$ high spreads, high debt, deep recessions, and longer
- Default episodes that resemble data
  - Long episodes on average, with many short
  - Deliver hump-shaped patterns for debt and partial default
  - Not resulting in a net reduction of debt but with sizable haircuts

Debt resolutions mechanisms

- Debt relief and bond covenants less useful than in standard theory

Empirical Properties of Sovereign Defaults

- Develop accounting framework to analyze data
- Use panel data for 37 emerging countries 50 years
  - World Bank data (WDI, International Debt Statistics, Debtor Reporting System): public debt in arrears, debt service, debt levels, GDP
  - Global Financial Indicators on EMBI+ yield spreads
- Document properties of partial default and default episodes

Accounting: Flows and Levels

- Each period sovereign owes lenders a_t - sum of coupons from past issuances
- Flexible partial default policy: sovereign pays $(1 - d_t)a_t$ and does not pay $d_t a_t$

$$\begin{aligned}
\text{Debt service}_t &= (1 - d_t)a_t \\
\text{Defaulted coupons}_t &= d_t a_t \\
\text{Debt due}_t &= \text{Debt service}_t + \text{Defaulted coupons}_t = a_t \\
\text{Partial default}_t &= \text{Defaulted coupons}/\text{Debt due} = d_t
\end{aligned}$$

- Debt level is present value of future coupon promises

$$\text{Debt}_t = \sum_{j=0}^{\infty} \frac{a_t^{t+j}}{R^j}$$

Accounting: Long-term Bonds and Partial Default Accumulation

- Map to tractable structure of long-term perpetuity bonds with decay δ (Hatchondo-Martinez 09)
  - Borrowing contract gives sovereign $q_t b_t$ with promises to repay $\delta^{j-1} b_t$ in future $t+j$
- Defaulted coupons $d_t a_t$ result in future obligations with PV $\kappa d_t a_t$

  Factor κ captures that sovereign accumulates debt in arrears and restructures
- A sovereign with debt due a_t, that borrows b_t, and partially defaults on $d_t a_t$ has

$$a_{t+1} = \delta\ a_t + (R - \delta)\ \kappa\ d_t\ a_t + b_t.$$

- Evolution of debt due incorporates all these
- Debt level is the present value of contractual payments due $\frac{a_{t+1}}{R-\delta}$

Accounting: Default episodes and haircuts

- Default episode: Sequence of periods with consecutive positive partial default

  Episode of **length** $N+1$ has $d_{t+j} > 0$ for $j = \{0, 1, ..., N\}$

- Defaulted coupons $d_t a_t$ during episode accumulated with factor κ result in new obligations n_t

$$n_{t+j+1} = \begin{cases} (R-\delta)\kappa d_{t+j} a_{t+j} + \delta n_{t+j} & \text{for } j = \{0, 1, ..., N\} \\ \delta^{j-N-1} n_{t+j} & \text{for } j = \{N+1, ..., \infty\} \end{cases}$$

- Restructured debt is the present value of new obligations n_t

$$\text{Restructured debt}_t = \sum_{j=1}^{N} \frac{(1-d_{t+j}) n_{t+j}}{R^j} + n_{t+N+1} \sum_{j=0}^{\infty} \frac{\delta^j}{R^{N+j+1}}$$

- Defaulted debt is the present value of the defaulted coupons

$$\text{Defaulted debt}_t = \sum_{j=0}^{N} \frac{d_{t+j} a_{t+j}}{R^j}$$

Accounting: Default episodes and haircuts

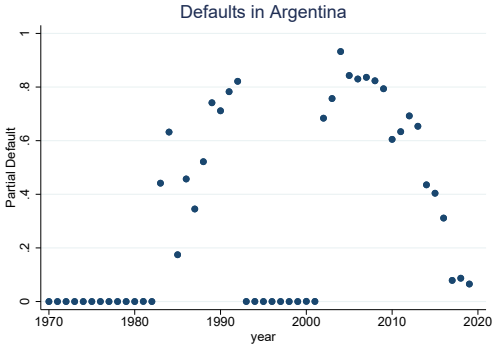
- Haircuts depend on value of the defaulted debt and the restructured debt (Cruces-Trebesch 13)

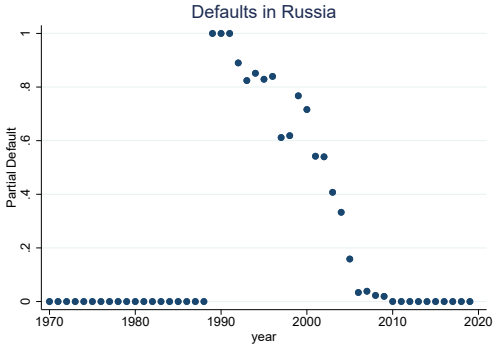
$$\text{Haircut}_t = 1 - \frac{\text{Restructured debt}_t}{\text{Defaulted debt}_t}$$

- In default episode sovereign carries its legacy debt due, restructured coupons, and borrowing
- Partial default and debt during the episode: sequences $\{d_{t+j}, \text{Debt}_{t+j}\}$ for $1 \leq j \leq N$

Use accounting framework to map data into our variables of interest

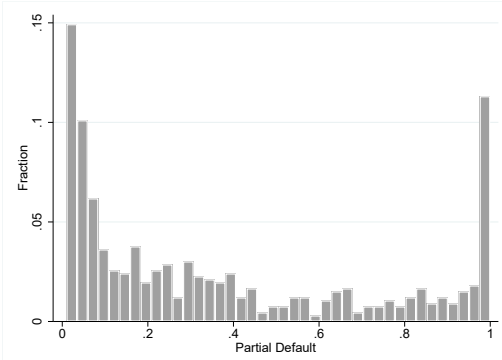
Partial Default and Episodes Examples



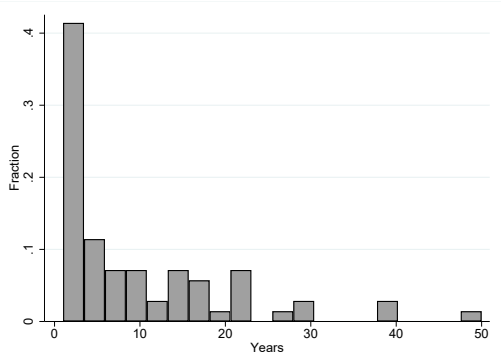


- Partial default frequent, varies in intensity
- Argentina experienced two episodes with lengths equal to 10 and 18 years
- Russia experienced one 20 year episode

Distribution of Partial Default and Episode Length



(a) Partial Default



(b) Default Episode Length

- Wide dispersion of partial default across countries and time
- Many short default episodes and a few countries always have positive default

Partial Default and Episodes across Countries

Partial Default			
Frequency			36
Mean | partial default >0			38
Standard deviation | partial default >0			22
Default Episodes			
Episode length (years)			9
Fraction of short episodes ($\leq$ 2 years)			36
Haircut (%)			36
Maturity extension (years)			6
Default Episodes Dynamics	Partial Default	Debt	Output
Before episode	0	32	0
Beginning of episode	22	34	-2
Middle of episode	33	40	-5
After episode	0	33	-3

- Frequent partial default, about 1/3, with mean 38%
- Long default episodes on average, but lots of short
- Hump-shaped partial default and debt during default episodes; U shaped for output

Data Summary

1. Partial default: one third of time positive, on average 38%, large variance
2. With higher partial default: higher spreads and debt, more depressed output
3. Default episodes:
   - Hump-shape dynamics in partial default and debt, U shape for output
   - Do not lead to a net reduction in debt

Model: Environment

- Small open economy with stochastic endowment z_t
- Borrows internationally long-term perpetuity bonds bonds with price q_t
- Lacks commitment and can partially default on its coupons
  - Default reduces income: cost depend on intensity d_t
  - Defaulted coupons accumulate with factor κ
  - With partial default, sovereign can continue to borrow at market higher rates
- International lenders risk neutral, bond prices compensate to default risk

Sovereign Borrower

- Preferences over consumption $E\sum_{t=0}^{\infty}\beta^t u(c_t)$
- Consumption is income y_t net of repayment of debt service and borrowing

$$c_t = y_t - a_t(1-d_t) + q(a_{t+1}, d_t, z_t)b_t$$

- Partial default d_t expands c_t but depresses income $y_{t+1} = z_{t+1}\psi(d_t, z_{t+1}) \leq z_{t+1}$

  Partial default and new borrowing is a portfolio problem
- Debt due = legacy debt δa_t + borrowing b_t + κ of new restructured $(R-\delta)\kappa d_t a_t$

$$a_{t+1} = \delta a_t + (R-\delta)\kappa d_t a_t + b_t$$

- Sovereign can always borrow, even with default but prices $q(a_{t+1}, d_t, z_t)$ respond

  d_t lowers prices because it increases a_{t+1} and lowers y_{t+1}

Recursive Problem and Bond Price

- State is (a, y, z): a debt due; y income (due to default history); z persistent productivity

$$V(a, y, z) = \max_{b,d \in [0,1]} \{u(c) + \beta E_z V(a', y', z')\}$$

subject to budget constraint, accumulation debt due, and income transition

- No separate problem for "default" states
- Bond price compensates for partial default loss to competitive lenders that discount at r

$$q(a', d, z) = \frac{1}{R} E \left(\underbrace{(1 - d(a', y', z'))}_{\text{partial default next}} + \left[\delta + \underbrace{(R - \delta)\kappa d(a', y', z')}_{\text{new restructured}} \right] \underbrace{q(a'', d', z')}_{\text{partial default future}} \right)$$

Trade-offs for Borrowing and Partial Default

- A portfolio-choice: Equate expected returns $R^b = R^d = u_c(c)/[\beta E u_c(c')]$

$$R^b \equiv \frac{R}{1 + q_{a'} b/q} + \text{cov}_1 = \frac{E z'(-\Psi_d)}{a(1 - q(R - \delta)\kappa) + q_d b} + \text{cov}_2 \equiv R^d$$

- Borrowing more attractive when q high and not too steep (R^b low)
- Partial default more attractive when a high, q low, default costs not too steep (R^d low)
- Steep bond price incentivizes exit from default episodes "induces deleveraging"

Quantitative Analysis

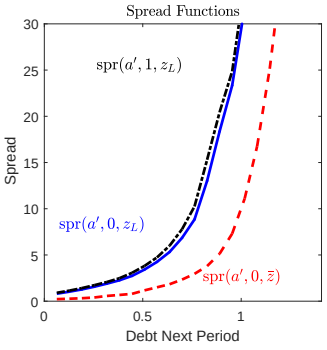
- Parameterize model to time series data of partial default and debt
  - Estimate 9 parameters (default cost parameters, discount factor, recovery factor, shock process, bond decay) to target 11 moments:
    properties of partial default, debt to output, debt service, and spreads
  - Apply accounting to model for time series statistics, default episodes, haircuts
- Evaluate model performance for partial default co-movements and default episodes
- Perform counterfactuals: debt relief, bond covenants
- Compare with reference model

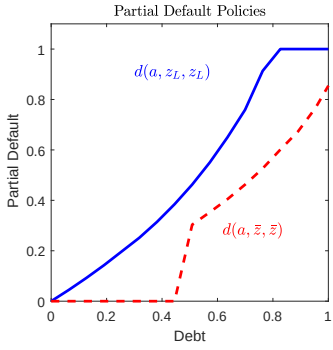
Model Fit: Moment Matching

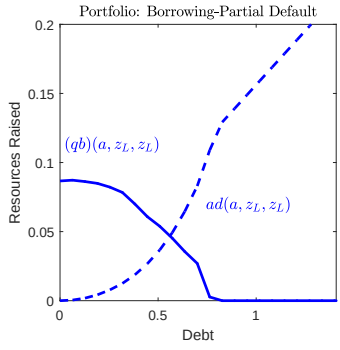
	Data	Model
Target Moments		
Partial default (in %)		
frequency	36	37
mean | partial default >0	38	39
st. dev. | partial default >0	22	19
Debt to output (in %)		
mean	32	32
st. dev.	18	25
Debt service to ouput (in %)		
mean	3.6	3.5
st. dev.	2.1	2.2
Debt due to output mean	4.9	5
Spread st. dev.	4.1	3.7
Output		
persistence	0.89	0.88
st. dev. (in %)	10	12

- Good fit overall: partial default, debt service, debt to output

Mechanisms: Spreads, Partial Default, and Portfolio







- Spreads smooth, mostly depend on a' not on d directly but $a' = \delta a + da\kappa(R - \delta) + b$
- Higher debt + high spread $\rightarrow$ larger partial default
- With low debt + low spread $\rightarrow$ borrow
- Partial default endogenously restrict new borrowing (default piles up debt due)

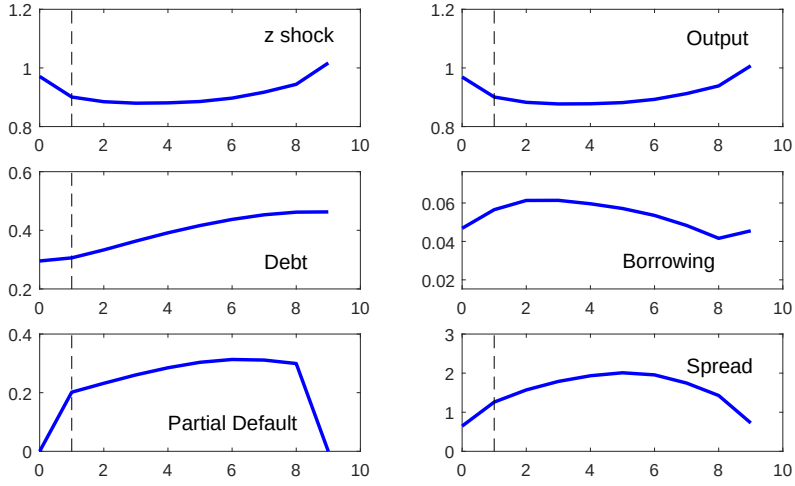
Default Episodes in Model and Data

	Data	Model
Mean episode length (years)	9	8
Percentage of short episodes (≤ 2)	36	42
Coefficient of variation for episode length	1.1	1.5
Haircut (%)	36	37
Maturity extension	6	7

Good fit for default episodes

- Model delivers long default episodes on average, with many short too
- Delivers haircuts and maturity extensions that resemble data

Default Episodes Model



- Default leads to more default, no reduction in debt
- Hump shape dynamics for partial default and debt; U shape for output

Default Episodes Dynamics in Model and Data

	Data	Model
Partial Default		
Before	0	0
Beginning	22	21
Middle	33	28
End	0	0
Output		
Before	0	0
Beginning	-2	-7
Middle	-5	-9
End	-3	3
Debt		
Before	32	32
Beginning	34	35
Middle	40	44
End	33	42

- Fits patterns in data
- Output and debt more accentuated in the model

Resolution Mechanisms Counterfactuals

PARI PASSU: NO MARKET ACCESS DURING DEFAULT

- Smaller haircuts on more recent issuances breaches pari passu (or equal treatment) clauses
- Pari passu might impede borrowing in default
- Defaulting becomes more costly, but credit is easier

DEBT RELIEF

- A permanent reduction in recovery factor κ
- Defaulting becomes less costly, but credit is harder

NO DILUTION COVENANTS

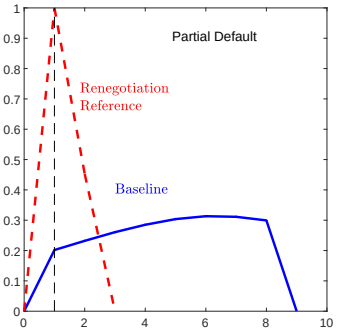
- Add no dilution covenants of Hatchondo-Martinez-SosaPadilla 2016
- Defaulting more costly, but credit easier

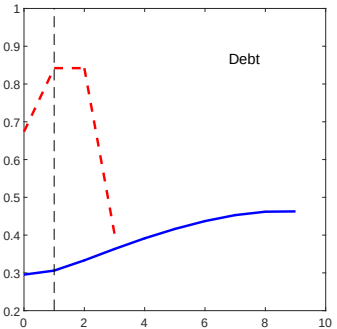
	Baseline	Pari Passu	Debt Relief	No-Dilution
Default Episodes				
Mean episode length (years)	8	2	8	6
Haircut (%)	37	32	46	36
Time series in (%)				
Partial default frequency	37	11	35	31
Debt to output mean	32	27	23	26
Spread st. dev.	3.7	1.1	2.3	0.9
Welfare rel. baseline (% CE)				
No debt, z_L	–	0.12	-0.11	0.07
Debt 64%, z_L	–	-0.07	0.05	-0.20
Overall Average	–	0.03	-0.04	-0.01

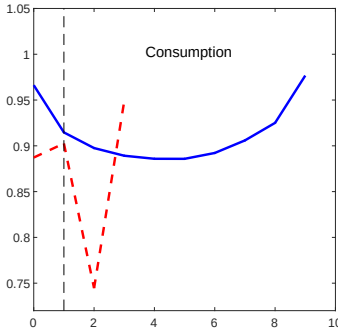
- Pari Passu: Less frequent partial default, shorter episodes, improves welfare when debt low
- Debt Relief: Larger haircuts and lower debt, improves welfare when debt high
- No Dilution: Lower debt, reduced partial default, improves welfare when debt low

Reference Model: Renegotiation with Bargaining

Model with full default + renegotiation with alternating offers between country and lenders







- Default episodes short in reference model
- Debt collapses upon default + burst borrowing and consumption upon re-entry
- Misses debt dynamics and amplification of default episodes

Conclusions

- Prior work focuses on dynamics prior to default, with fresh start after default
- Document rich dynamics during default and amplification of default
- Propose a theory with partial default: default leads to more default
  - Useful for rationalizing dynamics during default episodes, properties of partial default
- Theory potentially useful to analyze restructuring mechanisms
  - That can actually lead to a reduction in debt burden