Reserves and Sudden Stops

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Sovereign Debt, Financial Crises, Sudden Stops

- Gourinchas and Obstfeld (2012) - Stories of the Twentieth Century for the Twenty-First
- Heller (1966)
- Frankel and Jovanovic (1981)
- Alfaro and Kanczuk (2009)
- Jeane and Ranciere (2011)
- Bianchi et al. (2014) - International Reserves and Rollover Risk
- Hur and Kondo (2014) - A Theory of Rollover Risk, Reserves, and Sudden Stops

Gourinchas and Obstfeld (2012)

- Domestic credit expansion and real currency appreciation robustly predict financial crises
- For emerging economies, higher foreign exchange reserves predict a sharply reduced probability of a subsequent crisis

Crisis Types

- Currency crisis: managed exchange rate falls to speculative pressure
- Banking crisis: systemic banking failures which endanger the aggregate economy, possibly through various channels of contagion, etc.
- Government default crisis: default or market fears of explicit default on internal or external public debt
- Kaminsky and Reinhart document "twin" banking and currency crises where flight from the financial system leads to flight from the currency, leading to massive depreciation.
- These crises may also trigger a sovereign default crisis, although this may happen through simple fiscal profligacy as well.

Crisis Incidence

	Currency	Banking	Default	# Countries
Advanced	43	5	0	22
Emerging	84	57	74	57
Total	127	62	74	79

Source: Authors' calculations.

Table 1: Crisis Incidence in Advanced and Emerging Economies, 1970-2006

Data includes 57 emerging economies and 22 advanced economies

Emerging-Economy Weaknesses

- Political and economic instability
- Undeveloped and unstable financial market
- Dollarization (of debt), original sin (inability to borrow from foreigners in domestic currency), and currency mismatches
- Fear of floating (subject to currency attacks)
- Sudden stops (in foreign lending) and debt intolerance (sustainable external debt levels seem to be far less than that for advanced economies)
- Over regulation of nonfinancial markets (product and labor markets)

But Financial Development Led to...

- Growth of US banking assets seems moderate, but omits a substantial contribution from off-balance-sheet vehicles and "shadow banking sector"
- Regions with high growth in banking sector seem to have also been hit the hardest during the crisis of 2007-09.

	2003	2007	Change (percent of GDP)
European Union	210.3	307.9	97.6
United States	71.0	81.1	10.1
Japan	168.4	230.1	61.7
Asia	144.2	151.3	7.1
Emerging Europe	33.6	66.2	32.6
Latin American and Caribbean	51.9	62.1	10.2
Middle East and North Africa	78.7	85.7	7.1
Sub-saharan Africa	71.3	78.5	7.1
World	136.5	174.6	38.1

Source: IMF, *Global Financial Stability Report*, various issues.

Table 2: Commercial Bank Assets as a Percentage of GDP

What Determines Crises?

- Panel logit model with country fixed effects

$$P\left(y_j^k = 1 \mid x\right) = \frac{e^{x'\gamma_j^k}}{1 + e^{x'\gamma_j^k}}$$

- y_j^k- equal to 1 if crisis j occurs between periods $t+1$ and $t+k$
- crisis probability depends on a vector x of macroeconomic variables
  - public debt, domestic credit, current account (percent output)
  - real exchange rate
  - log output deviation from trend
  - reserves, short-term external debt (percent output)

Banking Crises in Advance Economies

Panel A: Banking Crisis		1 year		1-2 years	
	sd.(x)	$\partial p/\partial x$	Δp	$\partial p/\partial x$	Δp
Public Debt/GDP	20.59	0.006	0.26	0.028	1.28*
		(0.007)	(0.24)	(0.020)	(0.69)
Credit/GDP	19.01	0.013	1.38	0.066	7.64**
		(0.015)	(0.96)	(0.048)	(2.26)
Current Account/GDP	3.75	0.016	0.08	0.080	0.44
		(0.022)	(0.12)	(0.078)	(0.47)
Real Exchange Rate	6.78	-0.003	-0.02	-0.029	-0.16
		(0.007)	(0.04)	(0.023)	(0.13)
Output Gap	2.26	0.057	0.31	0.211	0.89
		(0.078)	(0.42)	(0.195)	(0.86)
p (percent)		0.08		0.41	
N:18; NxT: 547					

Currency Crises in Advance Economies

Panel B: Currency Crisis		1 year		1-3 years	
	sd.(x)	$\partial p/\partial x$	Δp	$\partial p/\partial x$	Δp
Public Debt/GDP	22.19	-0.025	-0.49	-0.140*	-2.66**
		(0.029)	(0.51)	(0.078)	(1.27)
Credit/GDP	22.75	0.031	0.85	0.119*	3.12*
		(0.021)	(0.65)	(0.062)	(1.81)
Current Account/GDP	3.86	0.100	0.42	-0.508*	-1.77*
		(0.114)	(0.53)	(0.308)	(0.98)
Real Exchange Rate	7.28	-0.414**	-1.51**	-1.138**	-5.48**
		(0.128)	(0.66)	(0.211)	(0.83)
Output Gap	2.22	-0.542*	-0.89*	-0.277	-0.60
		(0.288)	(0.47)	(0.657)	(1.37)
p (percent)		1.88		8.80	
N: 15; NxT: 373					

Default Crises in Emerging Economies

Panel A: Default		1 year		1-3 years	
	sd.(x)	$\partial p/\partial x$	Δp	$\partial p/\partial x$	Δp
Public Debt/GDP	18.78	-0.021	-0.37	-0.193*	-3.11**
		(0.050)	(0.86)	(0.105)	(1.49)
Credit/GDP	7.64	0.417**	4.89**	1.138**	11.49**
		(0.129)	(1.70)	(0.197)	(2.44)
Current Account/GDP	4.03	0.236	1.08	0.150	0.63
		(0.249)	(1.27)	(0.548)	(2.36)
Reserves/GDP	4.58	-0.593**	-1.93**	-1.309**	-5.15**
		(0.299)	(0.69)	(0.516)	(1.56)
Real Exchange Rate	20.60	-0.052	-0.94*	-0.257**	-4.26**
		(0.032)	(0.51)	(0.089)	(1.24)
Short Term Debt/GDP	5.42	0.255**	1.66*	1.010**	6.43**
		(0.125)	(0.94)	(0.270)	(1.99)
Output Gap	3.79	-0.248	-0.83	0.195	0.75
		(0.205)	(0.61)	(0.489)	(1.93)
p (percent)		3.68		11.82	
N: 17; NxT: 360					

Banking Crises in Emerging Economies

Panel B: Banking Crisis		1 year		1-3 years	
	sd.(x)	$\partial p/\partial x$	Δp	$\partial p/\partial x$	Δp
Public Debt/GDP	22.27	0.017	0.41	0.152**	4.01**
		(0.023)	(0.58)	(0.055)	(1.68)
Credit/GDP	10.59	0.181**	2.70**	0.468**	6.35**
		(0.060)	(1.13)	(0.127)	(2.11)
Current Account/GDP	5.02	0.090	0.49	0.188	0.99
		(0.165)	(0.97)	(0.285)	(1.57)
Reserves/GDP	6.91	-0.323*	-1.55**	-1.099**	-5.22**
		(0.176)	(0.61)	(0.295)	(1.02)
Real Exchange Rate	19.99	-0.075**	-1.17**	-0.326**	-4.71**
		(0.028)	(0.36)	(0.073)	(0.84)
Short Term Debt/GDP	5.19	0.083	0.47	0.334*	1.89
		(0.108)	(0.65)	(0.202)	(1.24)
Output Gap	3.93	0.334	1.66	1.414**	7.34**
		(0.206)	(1.21)	(0.415)	(2.61)
p (percent)		2.81		8.94	
N:26; NxT: 571					

Currency Crises in Emerging Economies

Panel C: Currency Crisis		1 year		1-3 years	
	sd.(x)	$\partial p/\partial x$	Δp	$\partial p/\partial x$	Δp
Public Debt/GDP	17.17	0.050	0.96	0.097	1.85
		(0.037)	(0.80)	(0.062)	(1.32)
Credit/GDP	9.58	0.329**	4.99**	0.656**	9.36**
		(0.101)	(2.29)	(0.149)	(3.07)
Current Account/GDP	4.71	0.127	0.65	0.224	1.13
		(0.158)	(0.88)	(0.359)	(1.93)
Reserves/GDP	6.89	-0.667**	-2.56**	-1.372**	-5.36**
		(0.172)	(0.68)	(0.252)	(0.94)
Real Exchange Rate	18.15	-0.023	-0.40	-0.170**	-2.53**
		(0.033)	(0.53)	(0.069)	(0.89)
Short Term Debt/GDP	4.38	0.136	0.65	0.450	2.23
		(0.163)	(0.84)	(0.300)	(1.66)
Output Gap	3.78	0.387*	1.80*	0.451	1.90
		(0.202)	(1.07)	(0.288)	(1.33)
p (percent)		3.44		7.21	
N:26; NxT: 381					

Hur and Kondo (2013)

Extending Gourinchas and Obstfeld (2012), we find that reserves are also significantly associated with a reduced probability of sudden stop. We also find that net foreign assets are not commonly associated with crises.

	S.D.	1-2 years δp	1-2 years $\frac{\partial p}{\partial x}$	1-3 years δp	1-3 years $\frac{\partial p}{\partial x}$
Panel A: Sudden Stops					
Reserves	20.16	-7.13***	-0.52***	-10.43***	-0.68***
over External Debt		(1.45)	(0.14)	(2.28)	(0.19)
Net Foreign Assets	10.07	-3.86*	0.46	-8.33**	-1.00***
over GDP		(2.30)	(0.32)	(2.87)	(0.42)
Probability in percent (p)		11.76		20.37	
Panel B: Default Crises					
Reserves	21.58	-8.08***	-0.71***	-12.41***	-1.11***
over External Debt		(2.15)	(0.21)	(3.10)	(0.29)
Net Foreign Assets	7.79	-3.95*	0.63	-6.16**	-0.98*
over GDP		(2.34)	(0.47)	(2.88)	(0.56)
Probability in percent (p)		10.11		15.01	
Panel C: Banking Crises					
Reserves	27.98	-3.92	-0.42**	-7.12**	-0.69***
over External Debt		(2.47)	(0.17)	(3.00)	(0.18)
Net Foreign Assets	7.42	-0.89	-0.14	-1.64	0.25
over GDP		(0.95)	(0.16)	(1.45)	(0.24)
Probability in percent (p)		4.12		7.67	
Panel D: Currency Crises					
Reserves	24.54	-2.00	-0.36*	-4.52*	-0.70**
over External Debt		(1.65)	(0.21)	(2.49)	(0.25)
Net Foreign Assets	8.60	-0.43	0.04	1.95	0.19
over GDP		(0.94)	(0.09)	(2.10)	(0.18)
Probability in percent (p)		2.02		4.62	

Heller (1966)

- Determines optimal reserves to balance opportunity cost of reserves and adjustment costs associated with depleted reserves in the presence of *exogenous* BOP deficit shocks

Model

- Marginal adjustment cost $MC_a = \frac{1}{m}$, where m is the marginal propensity to import (a more open economy requires a relatively smaller "dampening" to accomodate BOP deficit)
- Marginal cost of reserves $MC_f = r$, where r is the social rate of return on capital minus the return on reserves
- Optimal level of reserves determined by

$$MC_f = r = \frac{\pi_t(R_t^*)}{m} = \pi_t(R_t^*)MC_a$$

where $\pi_t(R_t) = (0.5)^i$ is the probability of $i = \lceil R/h \rceil$ consecutive BOP deficits of size h

Optimal Reserves

- Optimal level of reserves:

$$R_t^* = h\frac{\log(rm)}{\log(0.5)}$$

Comments on Heller (1966)

- Reserves reduce the probability of costly BOP adjustments
- BOP deficits are exogenous
- Numerous papers follow this approach (Frankel and Jovanovic 1982)

Reserves to smooth consumption

- More recent papers have modeled reserves to help smooth consumption during
  - exogenous sudden stops (Jeanne and Ranciere 2011)
  - endogenous default (Alfaro and Kanczuk 2009, Bianchi et al. 2014)

Jeanne and Ranciere

- small open economy
- representative household borrows from abroad, subject to borrowing constraint (assumed to be always binding)
- sudden stops (in lending) occur exogenously
- government invests in sudden stop insurance contrancts ("reserves") to help smooth consumption

Households

$$\max_{C_t, L_t} \quad E_t\left[\sum_{i=0}^{\infty} \frac{u(C_{t+i})}{(1+r)^{-i}}\right]$$

$$s.t. \quad C_t = Y_t + L_t - (1+r)L_{t-1} + T_t$$

$$(1+r)L_t = \alpha_t Y_{t+1}^n$$

where T_t is government transfers

- In normal times

$$Y_t = Y_t^n \equiv (1+g)^t Y_0$$

$$\alpha_t = \alpha$$

Sudden Stops

- Sudden stops occur with exogenous probability π
- During sudden stops (which lasts θ periods)

$$\begin{aligned} Y_{t+\tau} &= Y^s_{t+\tau} \equiv (1-\gamma(\tau))\, Y^n_{t+\tau} \\ \alpha_{t+\tau} &= \alpha(\tau) \end{aligned}$$

where $\gamma(0) = \gamma$, $\gamma(\theta) = 0$, $\alpha(0) = 0$, and $\alpha(\theta) = \alpha$

Sudden Stops

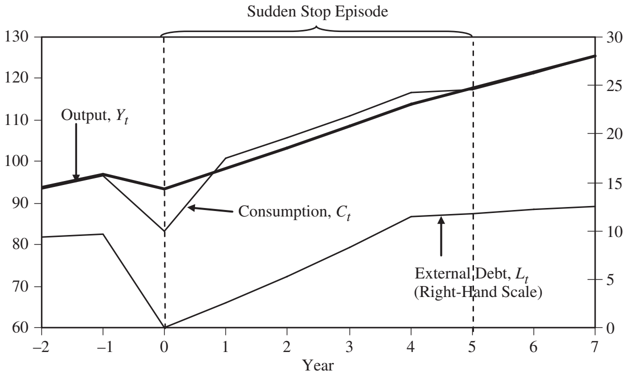


Fig. 1. *Output, External Debt and Consumption in a Sudden Stop*

Notes. The Figure shows the path of domestic output, consumption (left-hand scale) and external debt (right-hand scale) in a sudden stop episode starting in period 0 and lasting five periods. Trend output is normalised to 100 in the period of the sudden stop. The parameter values are those of the benchmark calibration given in Table 1; see Section 2.1.

Source. Authors' computations.

Government

- Governments can smooth domestic consumption against sudden stops by entering a "reserves insurance contract"
- Governments pay premium X_t and receive R_t in the event of a sudden stop
- Premium determined by lender's zero-profit condition

Optimal Reserves

- Assume that the borrowing constraint is always binding (authors derive conditions under which this holds)
- The optimal "reserves"-to-gdp ratio is given by

$$\frac{\lambda + \gamma - \left[1 - \frac{(r-g)}{1+g}\lambda\right](1 - p^{\frac{1}{\sigma}})}{1 - \frac{\pi}{\pi + p(1-\pi)}(1 - p^{\frac{1}{\sigma}})}$$

  where p is the relative price of non-crisis dollars to crisis dollars
- Reserves increase with short term-debt λ, output cost of sudden stop γ, and probability of sudden stop π

Sudden Stops

Table 1

Calibration Parameters

Parameters	Baseline	Range of Variation
Size of sudden stop	$\lambda = 0.10$	[0, 0.3]
Probability of a sudden stop	$\pi = 0.10$	[0, 0.25]
Output loss	$\gamma = 0.065$	[0, 0.2]
Potential output growth	$g = 0.033$	
Term premium	$\delta = 0.015$	[0.0025, 0.05]
Risk-free rate	$r = 0.05$	
Risk aversion	$\sigma = 2$	[1, 10]

Source. Authors' calculations using data from International Financial Statistics and Federal Reserve Board.

Results

Table 4

Output Cost of the 1997–1998 *Asian Crisis and the Optimal Level of Reserves in South East Asia*

Country	Outptut cost of 1997–8 sudden stop (in per cent of GDP)	Optimal level of reserves to GDP (risk aversion = 2)	Optimal level of reserves to GDP (risk aversion = 10)	Actual reserves to GDP (2005)
Korea	−14	0.16	0.22	0.25
Malaysia	−17	0.2	0.26	0.51
Philippines	−6	0.09	0.15	0.16
Thailand	−17	0.19	0.25	0.29

Notes. For each of the four Asian countries, the optimal level of reserves is computed using the output cost of the 1997–8 sudden stop for two levels of risk- aversion ($\sigma = 2$ and $\sigma = 10$). All the other parameters are identical to the baseline model calibration presented in Table 1. GDP, gross domestic product.

- High risk aversion is needed to justify the level of reserves observed

Comments on Jeanne and Ranciere (2011)

- Reserves increase with the exogenous probability of sudden stops
- How can we justify the increase in reserves in the last two decades?
- Quantitative results improve when authors impose a sudden probability that decreases with reserves
- We need a theory of the endogenous probabillity of sudden stops...

Alfaro and Kanczuk (2009)

- Extends Arellano (2008) to include reserves

Model

- Small open economy
- Risk neutral competitive foreign lenders
- Representative households have preferences $E_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$
- Household receives a stochastic stream of income y, which follows Markov process with transition function $f(y', y)$
- Government (benevolent planner) can issue non-state-contingent debt and accumulate reserves (risk-free assets)
- Default on debt leads to temporary exclusion and output costs

Government budget constraints

- If government honors its debt commitments,

$$c = y + b - q(b', a', y)b' + a - \frac{a'}{1+r}$$

where a is reserves, that pays $1 + r$ each period

- If government defaults,

$$c = (1 - \gamma)y + a - \frac{a'}{1+r}$$

where γ is the output loss in default

Option to Default

- Given the option to default,

$$v^o(b,a,y) = \max\left\{v^c(b,a,y), v^d(a,y)\right\} \quad (1)$$

- The value of not defaulting is given by

$$\begin{aligned} v^c(b,a,y) &= \max_{a'\geq 0,b'} \{u(c) + \beta\mathbb{E}v^o(b',a',y')\} \quad (2) \\ & \text{s.t. } c = y + b - q(b',a',y)b' + a - \frac{a'}{1+r} \end{aligned}$$

- The value of defaulting is given by

$$\begin{aligned} v^d(a,y) &= \max_{a'\geq 0} u(c) \quad (3) \\ & +\beta\mathbb{E}\left[(1-\theta)v^d(a',y') + \theta v^o(0,a',y')\right] \\ & \text{s.t. } c = (1-\gamma)y + a - \frac{a'}{1+r} \end{aligned}$$

Bond price schedule

- The bond price that satisfies the lender's zero profit condition:

$$q(b', a', y) \;=\; \frac{1 - \delta\,(b', a', y)}{1 + r} \tag{4}$$

where $\delta\,(b', a', y)$ denotes the probability of default next period

Functional Forms

- Endowments

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

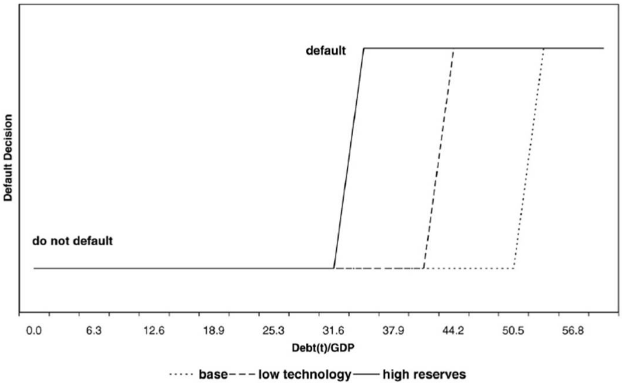
- Utility function

$$u(c) = c^{1-\sigma}/(1-\sigma)$$

Parameters

Parameter	Value	Target
interest rate r	0.04	
risk aversion σ	2	
endowment process ρ, σ_ϵ	0.85, 0.044	emerging economies (1965-)
reentry probability θ	0.5	duration of default
output cost γ	0.1	
discount factor β	0.5	

Default decision



- base $(\cdot, a = 0, y_{med})$, low technology $(\cdot, a = 0, y_{low})$, high reserves $(\cdot, a_{max}, y_{low})$
- reserves increase the motives to default

Main results

- Optimally governments hold no reserves
- Benefit of reserves: allows consumption smoothing during default
- is less than the cost of reserves:
    - sovereign impatience is higher than the reserves remuneration.
    - reserve holdings increase willingness to default $\rightarrow$ increase cost of borrowing

Comments

- Reserves increase default probability, in constrast to Gourinchas and Obstfeld (2012)
- Extensions with sudden stops not adequate - sudden stop interest rate $r_B = 0.2$ is still much lower than $1/\beta = 2$ and does not lead to a reduction in debt.
- Can reserves affect the probability of a sudden stop?

Bianchi, Hatchondo, and Martinez (2014)

- Extends Hatchondo and Martinez (2009) to include reserves

Model

- Small open economy
- Risk neutral competitive foreign lenders
- Representative households have preferences $E_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$
- Household receives a stochastic stream of income y, which follows Markov process with transition function $f(y', y)$
- Government (benevolent planner) can issue non-state-contingent long term debt and accumulate reserves (risk-free assets)
- Default on debt leads to temporary exclusion and output costs

Long-Duration Bonds

- As in Hatchondo and Martinez (2009), a bond issued in period t promises an infinite stream of coupons, which decreases at δ
- Law of motion of debt

$$b' = [b(1-\delta) - i]\,(1-d)$$

where $d = 1$ in default and i is the current issuance
- Face value of debt is given by

$$\frac{-b'}{\delta + r}$$

Government budget constraints

- If government honors its debt commitments,

$$c = y + b + a + q(b', a', y, s)i - \frac{a'}{1+r}$$

where a is reserves, that pays $1+r$ each period, and s is the "sudden stop" shock

- If government defaults,

$$c = y - \phi^d(y) + a - \frac{a'}{1+r}$$

where ϕ^d is the output loss in default

Sudden stop shock

- During a sudden stop, which occurs with probability π and ends with probability ψ^s, the government cannot issue debt and suffers an output loss of $\phi^s(y)$
- If government honors its debt commitments,

$$c = y - \phi^s(y) + b + a + q(b', a', y, s)i - \frac{a'}{1+r}$$

where $i \leq 0$

- If government defaults,

$$c = y - \phi^d(y) + a - \frac{a'}{1+r}$$

Option to Default

- Given the option to default,

$$v^o(b,a,y,s) = \max\left\{v^c(b,a,y,s), v^d(a,y,s)\right\} \tag{5}$$

- The value of not defaulting is given by

$$\begin{aligned} v^c(b,a,y,s) &= \max_{a' \geq 0, b'} \left\{u(c) + \beta \mathbb{E}_{(y',s')|(y,s)} v^o(b',a',y',s')\right\} \quad (6) \\ &\quad \text{s.t. } c = y - s\phi^s(y) + b + a - q(b',a',y,s)i - \frac{a'}{1+r} \end{aligned}$$

where $i' \leq 0$ if $s = 1$

- The value of defaulting is given by

$$\begin{aligned} v^d(a,y,s) &= \max_{a' \geq 0} u(c) \quad (7) \\ &\quad + \beta \mathbb{E}_{(y',s')|(y,s)} \left[(1-\psi^d) v^d(a',y',s') + \psi^d v^o(0,a',y',s')\right] \\ &\quad \text{s.t. } c = y - \phi^d(y) + a - \frac{a'}{1+r} \end{aligned}$$

Bond price schedule

- The bond price that satisfies the lender's zero profit condition:

$$\begin{aligned} q(b', a', y, s) &= \mathbb{E}_{(y', s')|(y,s)} \left[\frac{1 - d(b', a', y', s')}{1 + r} \right] + \\ & \mathbb{E}_{(y', s')|(y,s)} \left[\frac{1 - d(b', a', y', s')}{1 + r} (1 - \delta) q(b'', a'', y', s') \right] \end{aligned} \quad (8)$$

where $d(b', a', y', s')$ denotes the default policy and

$$\begin{aligned} b'' &= b^*(b', a', y', s') \\ a'' &= a^*(b', a', y', s') \end{aligned}$$

- first term: expected value of next-period coupon payment
- second term: expected value of all future coupon payments, summarized by the expected price of the bond next period

Markov Perfect Equilibrium

Definition

A Markov Perfect Equilibrium is a set of value functions v^o, v^c, v^d, a set of policy functions for default d, assets b, and reserves a, and a bond price function q such that

1. Taking as given the bond price function $q(B', y)$, the policy functions d, b, a and the value functions v^o, v^c, v^d solve the government optimization problem in (5)-(7)
2. Bonds price function q reflect government policies and are consistent with creditors' expected zero profits implicit in (8).

Functional Forms

- Endowments

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

- Utility function

$$u(c) = c^{1-\sigma}/(1-\sigma)$$

- Output loss

$$\phi^d(y) = \max\{0, d_0 y + d_1 y^2\}$$
$$\phi^s(y) = \lambda \phi^d(y)$$

  - $d_0 < 0,\ d_1 > 0$: similar to Arellano (2008)

- Yield i defined as the return an investor would earn if he holds the bond to maturity without default

$$q_t = \sum_{j=1}^{\infty} \frac{(1-\delta)^{j-1}}{(1+i)^j}$$

Parameters

Parameter	Value	Target
interest rate r	0.01	
endowment process $\rho, \sigma_\epsilon, \mu$	0.94, 0.015,-0.5σ_ϵ^2	Mexico output (1980.1-2011.4)
duration δ	0.033	average bond duration: 5 years
reentry probability ψ^d	0.083	duration of default
sudden stop probability π	0.025	sudden stop frequency
SS end probability ψ^s	0.25	sudden stop duration
discount factor β	0.95	mean debt: 0.43
risk aversion σ	4	$\sigma(c)/\sigma(y)$: 1
sudden stop cost λ	0.5	SS income cost: 0.14
output loss d_0, d_1	-0.189, 0.246	mean (2.9) and variance (1.5) of spread

Long-Run Statistics

	Model	Data
Mean Debt-to-GDP	46	43
Mean r_s	2.9	2.9
$\sigma\left(r_s\right)$	1.6	1.5
Mean sudden stop income cost (% annual income)	14	14
$\sigma(c)/\sigma(y)$	1.0	1.1
$\sigma(tb)$	1.3	1.4
$\rho\left(c, y\right)$	0.9	0.9
$\rho\left(r_s, y\right)$	-0.4	-0.5
$\rho(r_s, tb)$	0.3	0.6
Mean Reserves-to-GDP	7.5	9.0
$\rho(\Delta a, y)$	0.4	0.4
$\rho(\Delta b, y)$	0.4	0.9
$\rho(\Delta a, r_s)$	-0.3	-0.2

Moments are computed from 250 simulation samples with 120 periods without a default episode

Sudden stop episodes

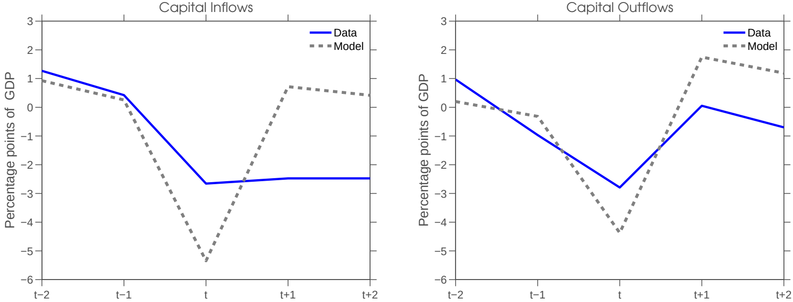


Figure 2: Average gross capital flows as a percentage of trend GDP in the simulations and in the data. The crisis year is denoted by t. In the simulations, we consider only sudden-stop episodes that do not trigger a default (in default episodes changes in the debt level do not correspond to changes in capital inflows). The behavior of flows in the data is the one presented by Broner et al. (2013b).

Bond price schedule

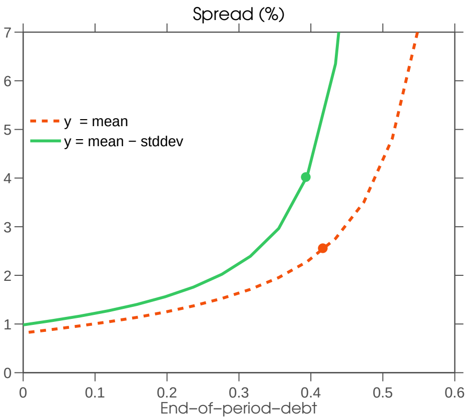


Figure 3: Menus of spread and end-of-period debt levels available to a government that is not facing a sudden stop and chooses a level of reserves equal to the mean in the simulations, i.e., $r^s(b', \bar{a}, y, 0)$, where $\bar{x}$ denotes the sample mean value of variable x. The solid dots present the spread and debt levels chosen by the government when it starts the period with debt and reserves levels equal to the mean levels observed in the simulations (for which it does not default).

Policy functions

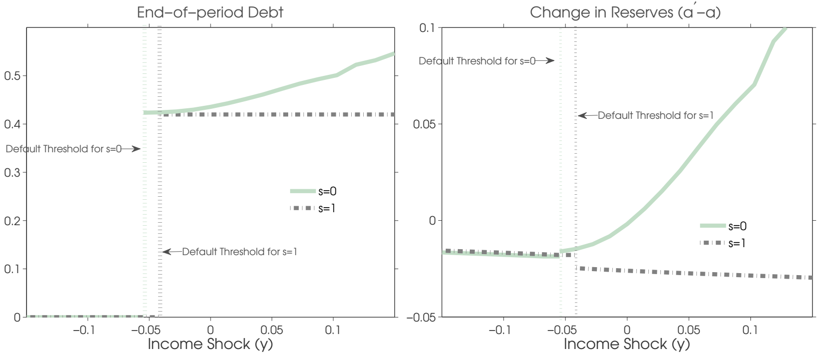


Figure 4: Equilibrium borrowing and reserve accumulation policies for a government that starts the period with levels of reserves and debt equal to the mean levels in the simulations. Debt levels and variations in reserves are presented as a percentage of the mean annualized income (4). That is, the left panel plots $\hat{b}\left(\bar{b}, \bar{a}, y, s\right)/4$ and the right panel plots $\left(\hat{a}\left(\bar{b}, \bar{a}, y, s\right) - \bar{a}\right)/4$.

Effect of reserves on spreads

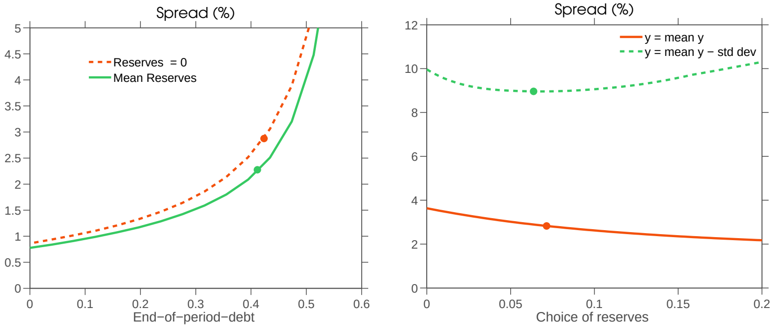
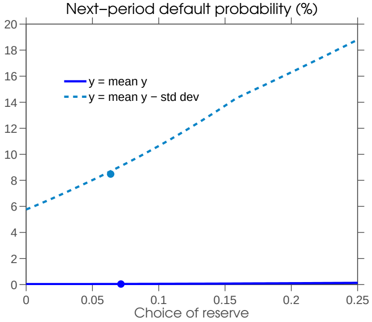


Figure 5: Effect of reserves on credit availability. The left panel presents menus of spread ($r^s(b', a', \bar{y}, 0)$) and end-of-period debt levels (b') available to a government that starts the period with the mean income and that does not face a sudden stop in the current period. Solid dots indicate optimal choices conditional on the assumed value of a'. The right panel presents the spread the government would pay if it chose the optimal borrowing level and different levels of reserves, $r^s(\hat{b}(\bar{b}, \bar{a}, y, 0), a', y, 0)$. Solid dots indicate optimal choices $(\hat{a}(\bar{b}, \bar{a}, y, 0), r^s(\hat{b}(\bar{b}, \bar{a}, y, 0), \hat{a}(\bar{b}, \bar{a}, y, 0)y, 0))$.

Effect of reserves on default probability



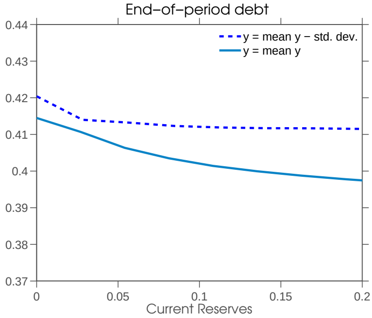


Figure 6: Effect of reserves on next-period default probability and borrowing. The left panel presents the next-period default probability $\left(Pr\left(V^D\left(b', a', y', s'\right) > V^R\left(b', a', y', s'\right) \mid y, s\right)\right)$ as a function of a' when $b' = \hat{b}\left(\bar{b}, \bar{a}, y, 0\right)$. Solid dots mark the optimal choice of reserves when initial debt and reserves levels are equal to the mean levels in the simulations $\left(\hat{a}\left(\bar{b}, \bar{a}, y, 0\right)\right)$. The right panel presents the optimal debt choice $\hat{b}\left(\bar{b}, a, y, 0\right)$ as a function of initial reserve holdings (a), assuming that the initial debt stock equals the mean debt stock in the simulations.

Comments on Bianchi et al. (2014)

- Why do emerging economies borrow and save at the same time?
  - Because long-term debt rates may rise: 'rollover risk'
  - In good times, borrow at low rates and save using reserves
  - In bad times, high rates so consume and repay using savings
  - Reserves also influence both the incentives to default and borrow
- Overall, a thorough quantitative exercise
- A nice combination of numerous channels in the literature

Comments: reserves and hedging

- Arellano and Ramanarayan (2012) feature a model of long term debt ($b \leq 0$) and short term debt ($a \leq 0$)
- Alfaro and Kanczuk (2009) show governments prefer reducing (short term) debt instead of holding reserves

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- Alfaro and Kanczuk (2009) show governments prefer reducing (short term) debt instead of holding reserves

- The paper could more carefully explore the hedging role of reserves in the presence of **both** short term debt and long term debt
    - Most likely, only the insurance role of reserves against exogenous sudden stops will survive

Comments: reserves, sudden stops, and default

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- In bad times, reserves in this paper increase default probability

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- Reserves play different roles in crisis times and in normal times
- In bad times, reserves in this paper increase default probability
- How does the model perform **during** sudden stops?
  - Is default more likely for countries with high reserves?
- Reserves do not affect sudden stop probability, in constrast to Gourinchas and Obstfeld (2012) and Calvo et al. (2012)
  - They do run an exercise in which reserves reduce the probability of sudden stop (in an exogenous way), improving the quantitative results
  - Hur and Kondo (2014) provide a theory for this