Reserve Accumulation, Macroeconomic Stabilization and Sovereign Risk

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Data: large holdings of int'l reserves, particularly for countries w/ currency pegs

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Our paper:

- Theory based on the **desirability** to hold reserves to manage macroeconomic stability under sovereign risk concerns

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A theory of reserve accum. based on **macro stabilization** and **sovereign risk**

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- Model of sovereign default and reserve accumulation w/ nominal rigidities

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- Why not just borrow? These are precisely the states in which spreads $\uparrow$
- Reserves give a "hedge" against having to roll-over the debt in bad times and free up resources to mitigate the recession

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Key insight: when output is partly demand determined, larger gross positions help smooth aggregate demand, reduce severity of recessions and facilitate repayment

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Policy: simple and implementable rules for res. accum. can deliver significant gains

Related Literature

Two main related branches of the literature:

Reserve accumulation: Aizenmann and Lee (2005); Jeanne and Ranciere (2011) ; Durdu, Mendoza and Terrones (2009); Alfaro and Kanczuk (2009), Bianchi, Hatchondo and Martinez (2018); Hur and Kondo (2016); Amador et al. (2018); Arce, Bengui and Bianchi (2019); Bocola and Lorenzoni (2018); Cespedes and Chang (2019)

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Main Elements of the Model

- Small open economy (SOE) with $T - NT$ goods:
  - Stochastic endowment for tradables y^T
  - Non-tradables produced with labor: $y^N = F(h)$
- Wages are downward rigid in domestic currency (SGU, 2016)
  - With fixed exchange rate, $\pi^\star = 0$ and L.O.P. $\Rightarrow$ wages are rigid in tradable goods $w \geq \overline{w}$
- Government issues non-contingent long-duration bonds (b) and saves in one-period risk free assets (a), all in units of T
- Default entails one-period exclusion and utility loss $\psi_d(y^T)$
- Risk averse foreign lenders $\rightarrow$ "risk-premium shocks"

Households

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \{u(c_t)\}$$

$$c = C(c^T, c^N) = [\omega(c^T)^{-\mu} + (1-\omega)(c^N)^{-\mu}]^{-1/\mu}$$

- Budget constraint in units of tradables

$$c_t^T + p_t^N c_t^N = y_t^T + \phi_t^N + w_t h_t^s - \tau_t$$

- ϕ_t^N: firms' profits; τ_t: taxes. No direct access to external credit.

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- Optimality

$$p_t^N = \frac{1-\omega}{\omega} \left(\frac{c_t^T}{c_t^N} \right)^{1+\mu}$$

Firms

- Maximize profits given by

$$\phi_t^N = \max_{h_t} p_t^N F(h_t) - w_t h_t$$

- p_t^N, w_t: price of non-tradables and wages in units of tradables
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Equilibrium in the Labor Market

Assume: $F(h) = h^{\alpha}$ with $\alpha \in (0,1]$.

Optimality conditions imply:

$$\mathcal{H}(c^T, w) = \left[\frac{1-\omega}{\omega}\,\frac{\alpha}{w}\right]^{1/(1+\alpha\mu)} (c^T)^{\frac{1+\mu}{1+\alpha\mu}}$$

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$$\text{Equilib. employment} = \begin{cases} \mathcal{H}(c^T, \overline{w}) & \text{for } w = \overline{w} \\ \bar{h} & \text{for } w > \overline{w} \end{cases}$$

plot

Asset/Debt Structure

- Long-term bond:
    - Bond pays $\delta\left[1,(1-\delta),(1-\delta)^2,(1-\delta)^3,...\right]$
    - Law of motion for bonds $b_{t+1}=b_t(1-\delta)+i_t$
    - price is q

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  - price is q
- Risk-free one-period asset which pays one unit of consumption
  - price is q_a
- Government's budget constraint if **repay:**

$$q_a a_{t+1} + b_t\delta = \tau_t + a_t + q_t \underbrace{\left(b_{t+1} - (1-\delta)b_t\right)}_{i_t\text{ : debt issuance}}$$

- Government's budget constraint in **default:**

$$q_a a_{t+1} = \tau_t + a_t$$

Foreign Investors

▸ more

- Competitive, deep-pocketed foreign lenders, subject to "risk-premium" shocks:

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$$q_a = \mathbb{E}_{s'|s} m(s, s') = e^{-r}$$

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- Bond price given by: $q = \mathbb{E}_{s'|s} \{m(s, s')(1 - d') [\delta + (1 - \delta) q']\}$

$$d' = \hat{d}(a', b', s'), \quad q' = q(a'', b'', s')$$

Recursive Problem

$$V\left(b,a,s\right)=\max_{d\in\{0,1\}}\left\{(1-d)V^{R}\left(b,a,s\right)+d\,V^{D}\left(a,s\right)\right\}$$

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$$\text{subject to}$$

$$c^T + q_a a' + \delta b = a + y^T + q\left(b',a',s\right)\left(b' - (1-\delta)b\right)$$

$$h \leq \mathcal{H}(c^T, \overline{w})$$

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$\mathcal{H}(c^T, \overline{w}) \rightarrow$ summarizes implementability const. from labor mkt & wage rigidity

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- Total repudiation, utility cost of default, 1-period exclusion
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$$V^D(a,s) = \max_{c^T, h \leq \overline{h}, a'} \left\{ u\left(c^T, F(h)\right) - \psi_d\left(y^T\right) + \beta \mathbb{E}_{s'|s}\left[V\left(0, a', s'\right)\right] \right\}$$

subject to

$$c^T + q_a a' = y^T + a$$

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Perturbation: issue additional unit of debt to buy reserves. Keep $\overline{c}$. From tomorrow onward, optimal policy.

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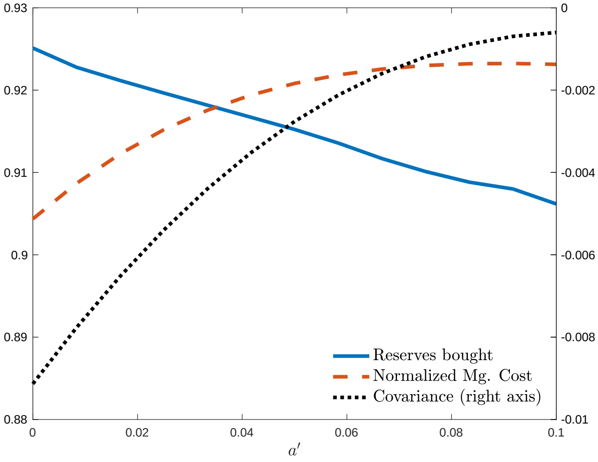
With 1-period debt ($\delta = 1$): $\mathbb{COV}_{s'|s,d'=0}\left(\delta + (1-\delta) q', u'_T + \xi' \mathcal{H}'_T\right) = 0$

Optimal Portfolio: gains from borrowing to buy reserves



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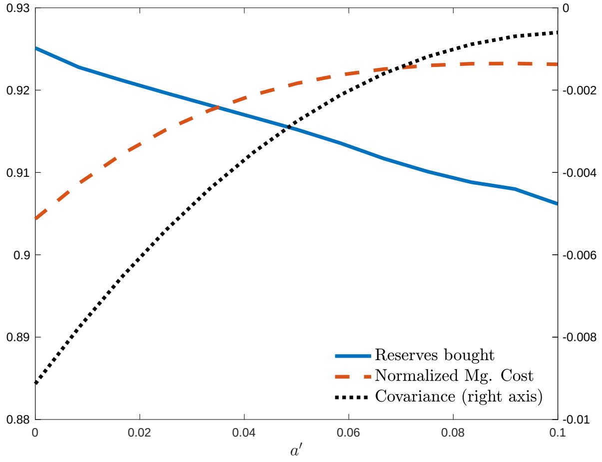

Covariance: negative (macro-stabilitization hedging) and upward sloping

Benefits of reserve accumulation

We want to highlight <u>two</u> benefits of reserves:

i. Higher reserves can reduce future unemployment.

ii. Reserve accumulation may improve bond prices.

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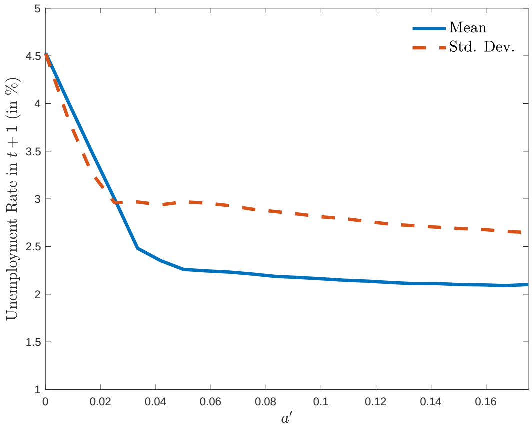
Exercise:

- Fix a point in the s.s. and a given level of consumption $\overline{c}$.
- Look at alternative a', and find b' that ensures $c = \overline{c}$.

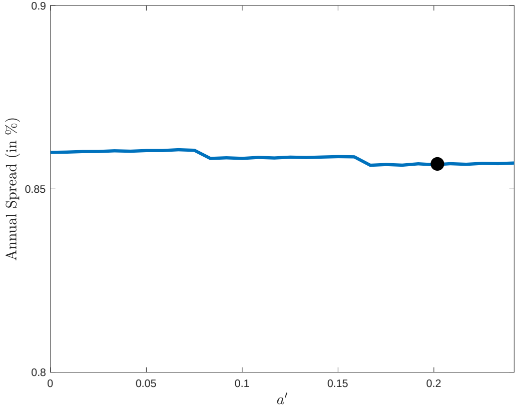
Next-period unemployment for given (a', b'): mean and std. dev.

▸ densities



Note: higher reserves **reduce** future unemployment

Borrowing to save may improve bond prices



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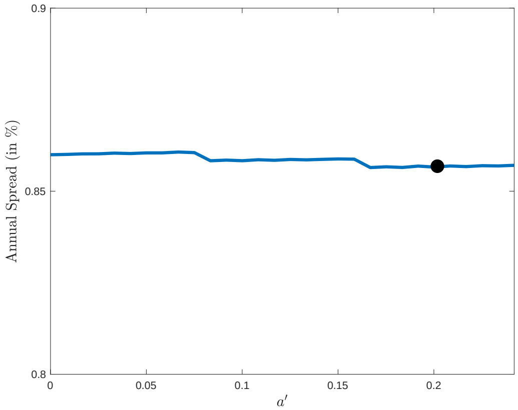
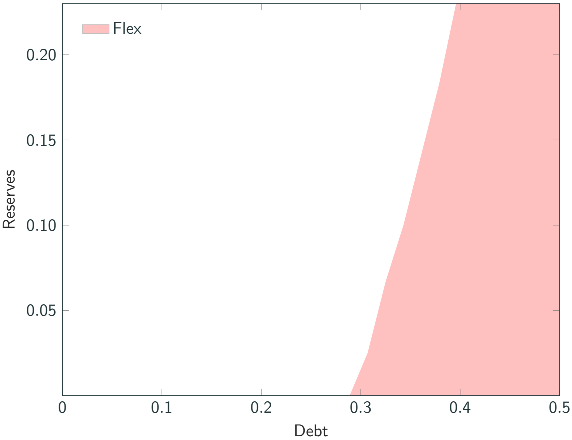


Intuition: Reserves increase V^R and V^D. If gov. is borrowing constrained (high unemployment), effect on V^R may dominate effect on V^D.

Results: default regions

▸ spread plots



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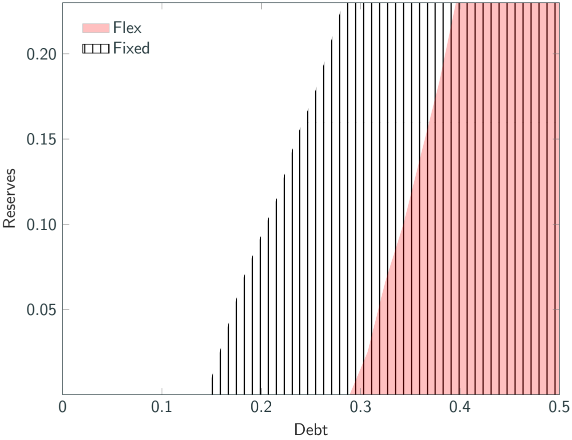

- Nominal rigidities **increase** default incentives

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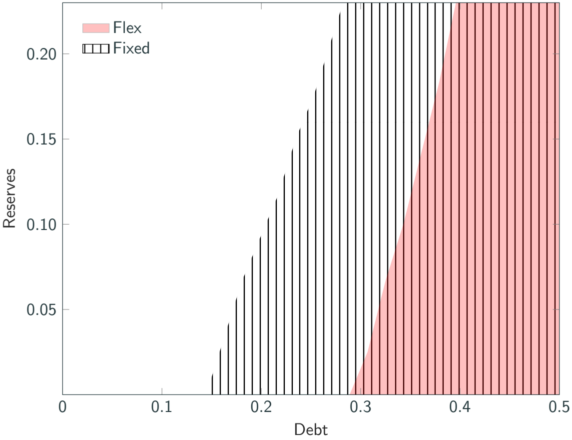

- Nominal rigidities **increase** default incentives
- Gross positions matter for default incentives

Quantitative Analysis

- Calibrate to the average of a panel of 22 EMEs (1990–2015).
- Benchmark = economy with nominal rigidities.
- 1 model period = 1 year.

Quantitative Analysis – Functional forms

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Utility function:

$$u(c) = \frac{c^{1-\gamma} - 1}{1-\gamma}, \text{ with } \gamma \neq 1$$

Utility cost of defaulting:

$$\psi_d(y^T) = \psi_0 + \psi_1 log(y^T)$$

Tradable income process:

$$\log(y_t^T) = (1-\rho)\mu_y + \rho log(y_{t-1}^T) + \epsilon_t$$

with $|\rho| < 1$ and $\epsilon_t \sim N(0, \sigma_\epsilon^2)$

Quantitative Analysis – Calibration

Parameter	Description	Value
r	Risk-free rate	0.04
α	Labor share in the non-tradable sector	0.75
β	Domestic discount factor	0.90
π_{LH}	Prob. of transitioning to high risk premium	0.15
π_{HL}	Prob. of transitioning to low risk premium	0.8
σ_ε	Std. dev. of innovation to $log(y^T)$	0.045
ρ	Autocorrelation of $log(y^T)$	0.84
μ_y	Mean of $log(y^T)$	$-\frac{1}{2}\sigma_\varepsilon^2$
δ	Coupon decaying rate	0.2845
$1/(1+\mu)$	Intratemporal elast. of subs.	.44
γ	Coefficient of relative risk aversion	2.273
$\overline{h}$	Time endowment	1
	Parameters set by simulation	
ω	Share of tradables	0.4
ψ_0	Default cost parameter	3.6
ψ_1	Default cost parameter	22
κ_H	Pricing kernel parameter	15
$\overline{w}$	Lower bound on wages	0.98

Results – road map

1. Simulations moments.
2. Welfare exercises.
3. Simple, implementable reserve accumulation rules.
4. Inflation targeting variant.

Results: data and simulation moments

	Data	Model Benchmark
Targeted		
Mean debt (b/y)	45	44
Mean r_s	2.9	2.9
Δr_s w/ risk-prem. shock	2.0	2.0
Δ UR around crises	2.0	2.0
Mean y^T/y	41	41
Non-Targeted		
$\sigma(c)/\sigma(y)$	1.1	1.0
$\sigma(r_s)$ (in %)	1.6	3.1
$\rho(r_s, y)$	-0.3	-0.6
$\rho(c, y)$	0.6	1.0
Mean Reserves (a/y)	16	16
Mean Reserves/Debt (a/b)	35	35
$\rho(a/y, r_s)$	-0.4	-0.4

Results: data and simulation moments

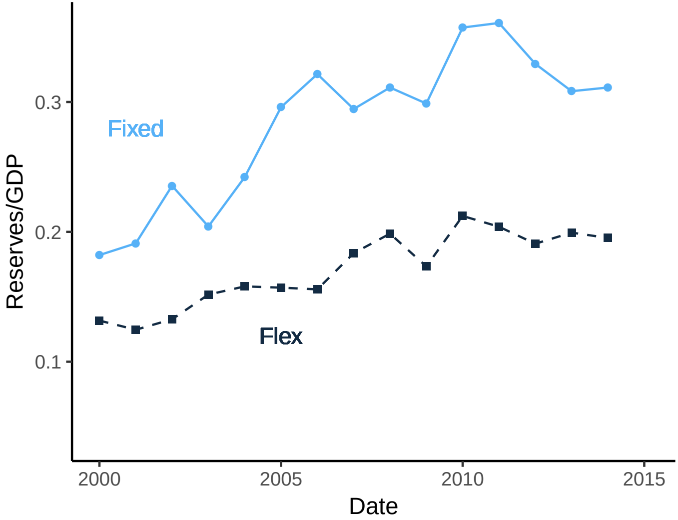
	Data	Model Benchmark
Targeted		
Mean debt (b/y)	45	44
Mean r_s	2.9	2.9
Δr_s w/ risk-prem. shock	2.0	2.0
Δ UR around crises	2.0	2.0
Mean y^T/y	41	41
Non-Targeted		
$\sigma(c)/\sigma(y)$	1.1	1.0
$\sigma(r_s)$ (in %)	1.6	3.1
$\rho(r_s, y)$	-0.3	-0.6
$\rho(c, y)$	0.6	1.0
Mean Reserves (a/y)	16	16
Mean Reserves/Debt (a/b)	35	35
$\rho(a/y, r_s)$	-0.4	-0.4

Results: data and simulation moments

	Data	Model Benchmark	Model Flexible
Targeted			
Mean debt (b/y)	45	44	46
Mean r_s	2.9	2.9	3.0
Δr_s w/ risk-prem. shock	2.0	2.0	1.9
Δ UR around crises	2.0	2.0	0.0
Mean y^T/y	41	41	41
Non-Targeted			
$\sigma(c)/\sigma(y)$	1.1	1.0	1.1
$\sigma(r_s)$ (in %)	1.6	3.1	2.9
$\rho(r_s, y)$	-0.3	-0.6	-0.8
$\rho(c, y)$	0.6	1.0	1.0
Mean Reserves (a/y)	16	16	7
Mean Reserves/Debt (a/b)	35	35	15
$\rho(a/y, r_s)$	-0.4	-0.4	-0.6

Reserves in the data: fixed vs. flex

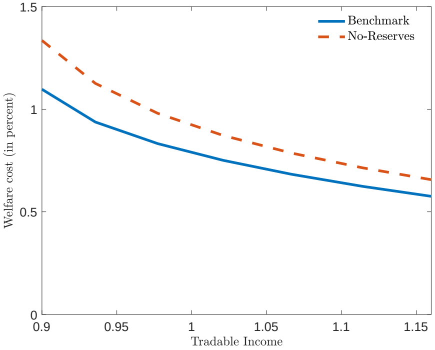
more



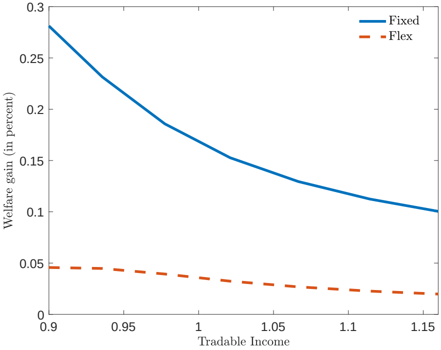
Welfare implications

▸ more

Welfare costs of rigidities



Welfare gain of reserves



Welfare implications

▸ more

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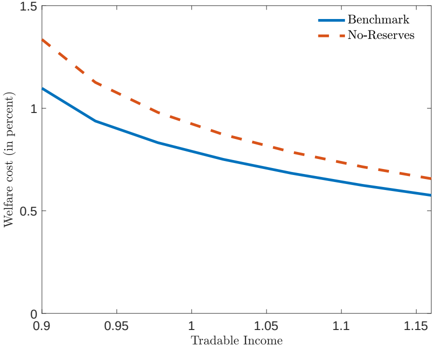

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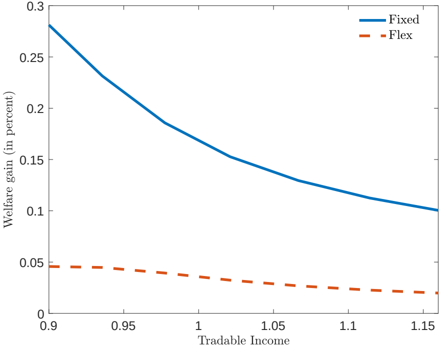
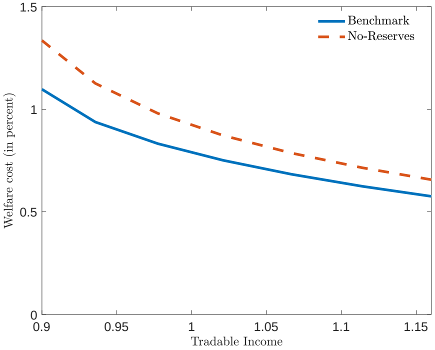


- Nominal rigidities decrease welfare by around 0.9% and are costlier if cannot accumulate reserves

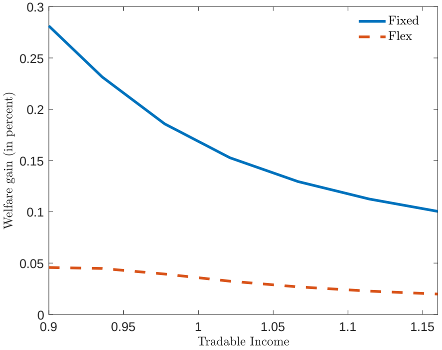
Welfare implications

▸ more

Welfare costs of rigidities



Welfare gain of reserves



- Nominal rigidities decrease welfare by around 0.9% and are costlier if cannot accumulate reserves
- Having access to reserves is welfare improving, especially w/ nominal rigidities

Simple and implementable reserve accumulation rules

- Policy discussion: what constitutes an “adequate” amount of reserves?

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1 p.p. increase in spreads, controlling for other factors, should lead to reserves declining 1.69% of mean (tradable) output (roughly 0.70% of GDP)

Simple and implementable reserve accumulation rules

	Benchmark	Rules	
		Best Rule	Greenspan-Guidotti
Targeted			
Mean debt (b/y)	44	42	19
Mean r_s	2.9	2.8	2.4
Δr_s w/ risk-prem. shock	2.0	1.9	1.7
Δ UR around crises	2.0	2.0	1.8
Mean y^T/y	41	41	40
Non-Targeted			
$\sigma(c)/\sigma(y)$	1.0	1.0	1.0
$\sigma(r_s)$ (in %)	3.1	3.0	2.7
$\rho(r_s, y)$	-0.6	-0.6	-0.7
$\rho(c, y)$	1.0	1.0	1.0
Mean Reserves (a/y)	16	15	6
Mean Reserves/Debt (a/b)	35	38	31
$\rho(a/y, r_s)$	-0.4	-0.7	0.5
Reserves/S.T. liabilities	112	139	100
Welfare gain (vs. No-Reserves)	0.18	0.07	-0.22

Simple and implementable reserve accumulation rules

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Inflation Targeting

▸ (more)

Inflation Targeting

▸ (more)

	Data	Model	
		Fixed Exchange Rate	Inflation Targeting
Targeted			
Mean debt (b/y)	45	44	51
Mean r_s	2.9	2.9	2.8
Δr_s w/ risk-prem. shock	2.0	2.0	2.1
Δ UR around crises	2.0	2.0	0.5
Mean y^T/y	41	41	42
Non-Targeted			
$\sigma(c)/\sigma(y)$	1.1	1.0	1.1
$\sigma(r_s)$ (in %)	1.6	3.1	3.0
$\rho(r_s, y)$	-0.3	-0.6	-0.7
$\rho(c, y)$	0.6	1.0	1.0
Mean Reserves (a/y)	16	16	12
Mean Reserves/Debt (a/b)	35	35	23
$\rho(a/y, r_s)$	-0.4	-0.4	-0.3

Inflation Targeting

▸ (more)

	Data	Model	
		Fixed Exchange Rate	Inflation Targeting
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Mean debt (b/y)	45	44	51
Mean r_s	2.9	2.9	2.8
Δr_s w/ risk-prem. shock	2.0	2.0	2.1
Δ UR around crises	2.0	2.0	0.5
Mean y^T/y	41	41	42
Non-Targeted			
$\sigma(c)/\sigma(y)$	1.1	1.0	1.1
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Mean Reserves (a/y)	16	16	12
Mean Reserves/Debt (a/b)	35	35	23
$\rho(a/y, r_s)$	-0.4	-0.4	-0.3

Key: some form of monetary inflexibility is enough to create demand for reserves

Conclusions

- Provided a theory of reserve accum. for macro-stabilization and sovereign risk
- Reserves help reduce future unemployment risk and may improve bond prices

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Conclusions

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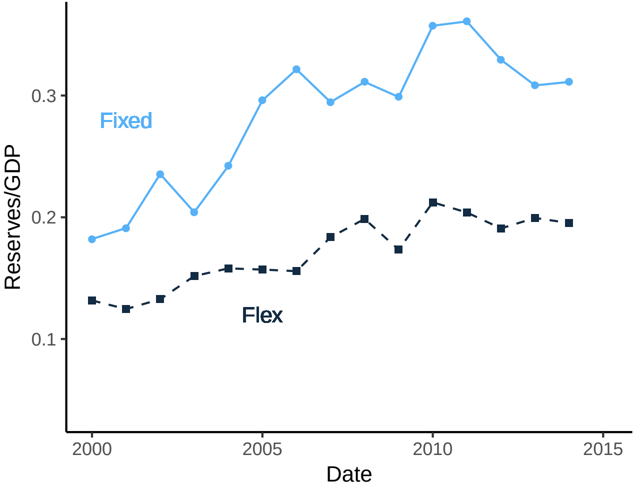
- Simple and implementable rules for res. accum. can deliver significant gains
- Agenda:
    - Equilibrium Multiplicity
    - Temptation to abandon pegs—how reserves can help

THANKS !

Reserves in the data: fixed vs. flex

(back)

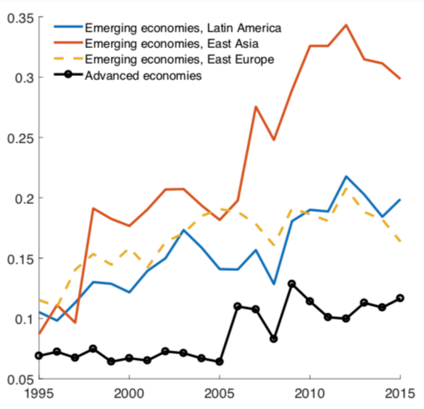


Massive holdings of international reserves, particularly for countries with fixed exchange rates

Reserves around the world

(back)

Over the past 20 years massive increase in reserves around the world, specially EMEs.



(from Amador, Bianchi, Bocola and Perri, 2018)

Reserve accumulation – Regressions

(back to motivation) (back to simulations)

	Dependent variable: $\log(Reserves/y)$				
	(1)	(2)	(3)	(4)	(5)
ERV	$\mathbf{-0.647}^{*}$	$\mathbf{-0.656}^{**}$	$\mathbf{-0.662}^{**}$	$\mathbf{-0.281}^{*}$	$\mathbf{-0.206}^{*}$
	(0.367)	(0.332)	(0.334)	(0.152)	(0.121)
$\log(Debt/y)$		0.245	0.250	0.349	0.324
		(0.214)	(0.244)	(0.240)	(0.203)
$\hat{y}$			−0.069	1.158	1.389
			(1.227)	(1.326)	(1.007)
$\log(Spread)$				−0.155	−0.063
				(0.095)	(0.093)
r^{world}					-0.119^{***}
					(0.038)
Number of countries	22	22	22	22	22
Observations	459	459	458	314	314
R^2	0.02	0.04	0.04	0.12	0.24
F Statistic	7.28^{***}	8.97^{***}	6.53^{***}	9.43^{***}	18.24^{***}

Note: All explanatory variables are lagged one period. $\hat{y}$ is the cyclical component of GDP. All specifications include country fixed effects. Robust standard errors (clustered at the country level) are reported in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Countries in our dataset

(back to motivation) (back to simulations)

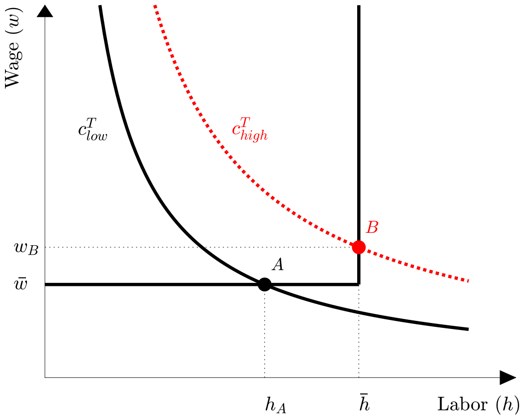
We use the IMF Classif. of Exch. Rate Arrangements (fixed = 1 and 2)

We follow Kondo and Hur (2016) and focus on 22 EMEs:

Argentina	India	Poland
Brazil	Indonesia	Romania
Chile	Malaysia	Russia
China	Mexico	South Africa
Colombia	Morocco	South Korea
Czech Republic	Pakistan	Thailand
Egypt	Peru	Turkey
Hungary		

Plot of the Labor Market Equilibrium

(back)



Foreign Investors' SDF – details

back

- Pricing kernel: a function of innovation to domestic income (ε) and a global factor $\nu = \{0, 1\}$ (assumed to be independent)

$$m_{t,t+1} = e^{-r - \nu_t(\kappa\varepsilon_{t+1} + 0.5\kappa^2\sigma_\varepsilon^2)}, \quad \text{with} \quad \kappa \geq 0,$$

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- Functional form + normality of ε $\rightarrow$ constant short-term rate:

$$\mathbb{E}_{s'|s} m(s, s') = e^{-r} = q_a, \qquad \text{with} \quad s = \{y^T, \nu\}$$

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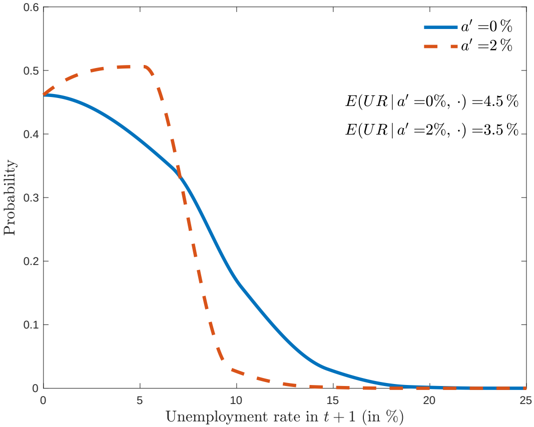
$$\mathbb{E}_{s'|s} m(s, s') = e^{-r} = q_a, \qquad \text{with} \quad s = \{y^T, \nu\}$$

- Bond price given by: $q = \mathbb{E}_{s'|s} \{m(s, s')(1 - d') [\delta + (1 - \delta) q']\}$
- Bond becomes a worse hedge if $\nu = 1$ and gov. tends to default with low ε

$\implies$ positive risk premium

Distribution of next-period unemployment for given (a', b')

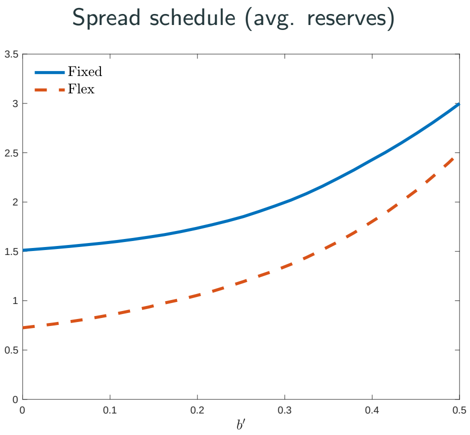
back

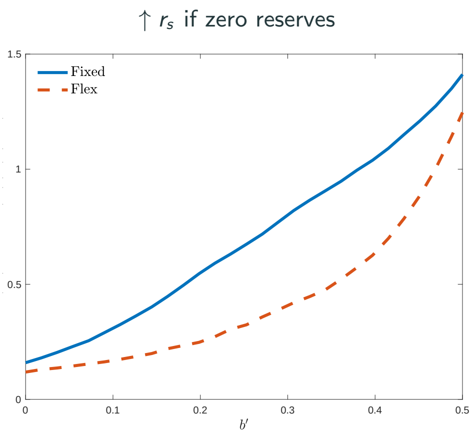


Note: higher reserves **reduce** future unemployment

Results: spreads, reserves and nominal rigidities

(back)

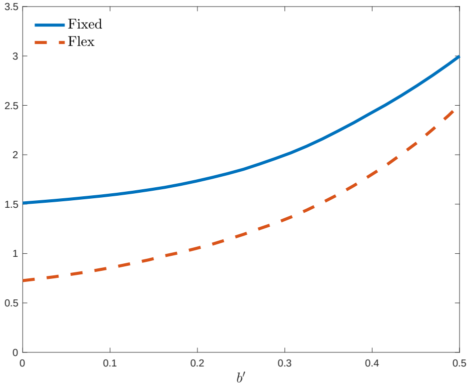




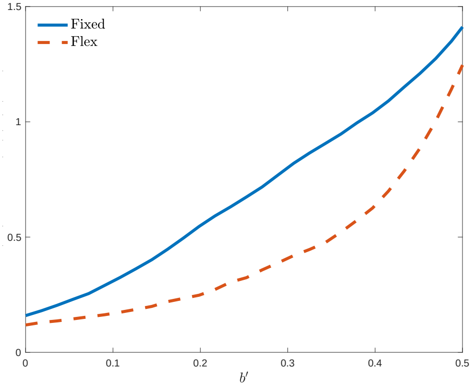
Results: spreads, reserves and nominal rigidities

(back)

Spread schedule (avg. reserves)



$\uparrow r_s$ if zero reserves

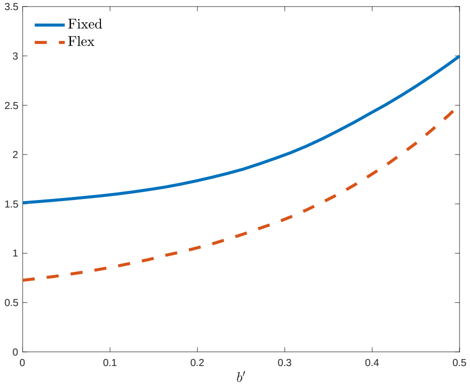


- Nominal rigidities **increase** spreads.

Results: spreads, reserves and nominal rigidities

▸ (back)

Spread schedule (avg. reserves)



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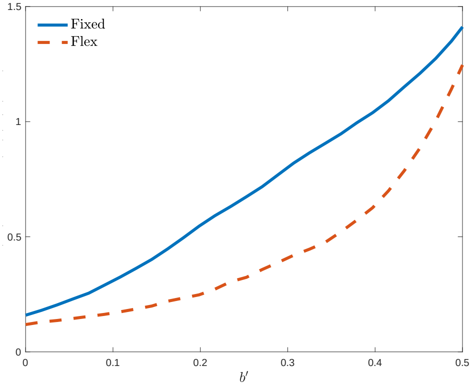

- Nominal rigidities **increase** spreads.
- Reserves **decrease** spreads, and **more** with nominal rigidities.

Appendix – Welfare

(back)

We'll compute **welfare costs** of 'moving' from a **baseline** economy to an **alternative** economy:

$$\text{Welfare gain } = 100 \times \left[\left(\frac{(1-\gamma)(1-\beta)V_{baseline} + 1}{(1-\gamma)(1-\beta)V_{alternative} + 1} \right)^{1/(1-\gamma)} - 1 \right]$$

Appendix – Welfare

(back)

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We're interested in studying:

- Costs of nominal rigidities
- Costs of not having access to reserves

To do this: define a "No-Reserves" economy (which can be under "fixed" or "flex").

Appendix – Welfare

(back)

Benchmark under fixed

Benchmark under flex

No-Reserves under fixed

No-Reserves under flex

Appendix – Welfare

(back)

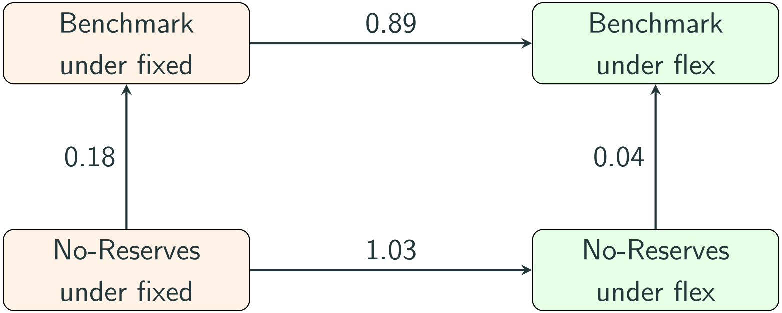
$$\text{Benchmark under fixed} \xrightarrow{0.89} \text{Benchmark under flex}$$

$$\text{No-Reserves under fixed} \xrightarrow{1.03} \text{No-Reserves under flex}$$

- Eliminating nominal rigidities is **welfare enhancing**, and more so when **reserve accumulation is not possible**.

Appendix – Welfare

(back)

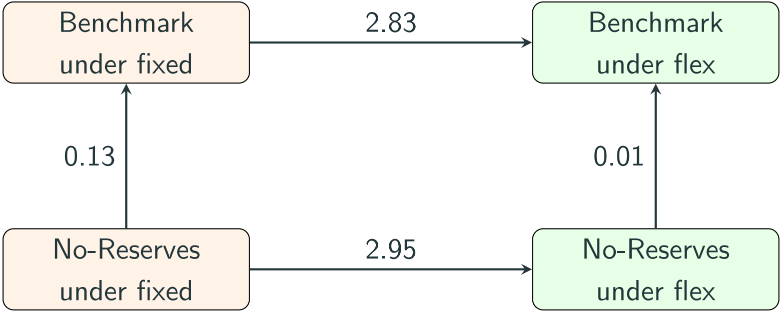


- Eliminating nominal rigidities is **welfare enhancing**, and more so when **reserve accumulation is not possible**.
- Being able to accumulate reserves is **welfare enhancing**, and more so under **fixed**.

Appendix – Welfare

(back)

Initial debt = Avg. in simulations. Initial reserves= zero.



Appendix – Inflation Targeting

(back)

- Define price aggregator as

$$P\left(P^T, P^N\right) \equiv \left(\omega^{\frac{1}{1+\mu}}\left(P^T\right)^{\frac{\mu}{1+\mu}} + (1-\omega)^{\frac{1}{1+\mu}}\left(P^N\right)^{\frac{\mu}{1+\mu}}\right)^{\frac{1+\mu}{\mu}}.$$

- Instead of fixing $e = 1$, gov. targets $P = \overline{P} > 0$

- All this yields an exchange rate policy

$$e = \overline{P}/\mathcal{P}\left(c^T, h\right) \tag{1}$$

- Replace fixed e for (1).