Reserve Accumulation, Macroeconomic Stabilization and Sovereign Risk

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August 2019

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Motivation

Conventional view: countries hold reserves to sustain pegs.

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  - A peg precludes the active use of seignoriage and sustaining a deficit may require the use of reserves.
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- Data (for EMEs):
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  - *Floaters* have non-trivial reserves, and
  - Seignoriage revenue is modest and has been $\downarrow$ over time.

To understand the role of the exc. rate regime in reserve accumulation we **need a theory** that goes **beyond purely fiscal considerations**.

Our paper

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- Show that countries w/ limited exc. rate flexibility choose to $\uparrow$ reserves for macro-stabilization purposes.
- Our theory is **not** based on the need to $\uparrow$ reserves to defend the peg (purely fiscal concerns).
- It's based on the desirability of $\uparrow$ reserves to manage macro stabilization when there is sovereign risk.
- We show this motive leads to a substantial demand for reserves, and can account for the patterns of reserve accumulation in the data.

What we do

Sovereign default model with long-term debt and **foreign reserve accumulation**, and **downward wage rigidity**.

- Rollover risk induces large fluctuations in borrowing costs
- When borrowing costs are high, aggregate demand contracts causing involuntary unemployment
- Holdings of reserves (liquid assets) help mitigate the fall in demand and the increase in unemployment
- In good times, government issues debt and buy reserves for macroeconomic stabilization

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Key insight: when output depends on aggregate demand, more hedging via reserve accumulation allows for better consumption smoothing **and** also reduces the severity of recessions.

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
  - With fixed exchange rate, $\pi^\star = 0$ and L.O.P., $\Rightarrow$ wages are rigid in tradable goods $w \geq \bar{w}$
- 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

- Households' preferences over consumption

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

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

- Budget constraint in units of tradables

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

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- Endowment of hours $\bar{h}$, but $h_t^s < \bar{h}$ when $w \geq \bar{w}$ binds.

- 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

- Firms' optimality condition is

$$p_t^N F'(h_t) \quad = \quad w_t$$

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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 asset pays one unit of consumption
  - price is q_a
- Government's budget constraint if **repay:**

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

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

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

Foreign Investors

- Pricing kernel is a function of innovation to domestic output 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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- Bond price given by:

$$q = \mathbb{E}_{s'|s} \left\{ m(s, s')(1 - d') \left[\delta + (1 - \delta)\, q' \right] \right\}$$
$$d' = \hat{d}(a', b', s'), \quad q' = q(a'', b'', s')$$

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- Risk premium ≥ 0 if default occurs with low ε and $\nu = 1$

Recursive Problem

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

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Value of repayment:

$$V^{r}\left(b,a,s\right)=\max_{b',a',h,c^{T}}\left\{u\left(c^{T},F(h)\right)+\beta\mathbb{E}_{s'|s}\left[V\left(b',a',s'\right)\right]\right\}$$

subject to

$$\begin{aligned}
c^{T}+g+q_{a}a' &= a+y^{T}+q\left(b',a',s\right)\left(b'-(1-\delta)b\right)-\delta b && [\lambda]\\
\bar{w} &\leq \frac{1-\omega}{\omega}\left(\frac{c^{T}}{F(h)}\right)^{1+\mu}F'(h) && [\xi]\\
h &\leq \bar{h} && [\eta]
\end{aligned}$$

Recursive Problem (ctd)

Value of default:

$$V^d(a,s) = \max_{c^T,h,a'} \left\{ u\left(c^T, F(h)\right) - \psi_d\left(y^T\right) + \beta \mathbb{E}_{s'|s}\left[V\left(0, a', s'\right)\right] \right\}$$

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Optimality Conditions – Labor Market

Assume $F(h) = h^{\alpha}$ with $\alpha \in (0, 1)$.
Also assume **(just for simplicity)**: $\mu = 0$.

Optimality in labor market implies:

$$h^d(w) = \left(\frac{1-\omega}{\omega}\right) \frac{\alpha}{w} c^T$$

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Equilibrium employment:

$$h(w) = \begin{cases} \left(\frac{1-\omega}{\omega}\right) \frac{\alpha}{w} c^T & \text{for } w = \bar{w} \\ \bar{h} & \text{for } w > \bar{w} \end{cases}$$

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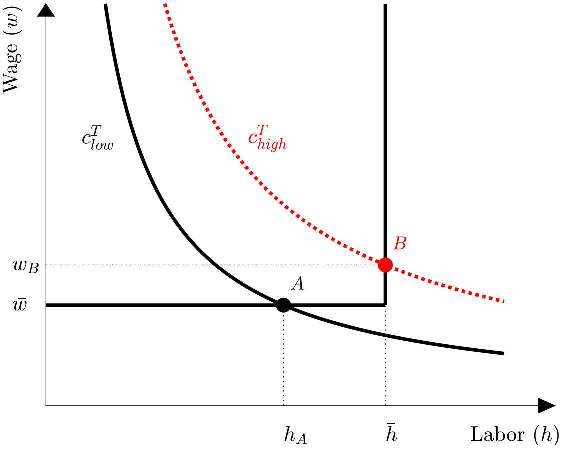
Labor Market Equilibrium



Optimality Conditions

FOC wrt c^T:

$$c^T: \quad u_T + \xi \qquad \left(\frac{1-\omega}{\omega}\right) \frac{\alpha}{\bar{w}} = \lambda$$

$\xi \rightarrow$ multiplier on the $w \geq \bar{w}$ constraint

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Tradable consumption has 2 benefits:

1. direct utility
2. reduction of unemployment

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Tradable consumption has 2 benefits:

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For labor, we have:

$$h: \quad u_N \, \alpha h^{\alpha-1} = \eta + \xi,$$

$\eta \rightarrow$ multiplier on the $h \leq \bar{h}$ constraint

Optimal Portfolio: gains from borrowing to buy reserves

Let $\tilde{a}$ denote reserves that can be purchased when issuing an additional unit of debt (for an initial state s):

$$\tilde{a} = \frac{q(\tilde{a}, b', s) + \frac{\partial q(\tilde{a}, b', s)}{\partial b'}}{q_a - \frac{\partial q(\tilde{a}, b', s)}{\partial a'}}.$$

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The effects on lifetime utility are:

$$\mathbb{E}_{s'|s}\left\{ \overbrace{\underbrace{\tilde{a}}_{\text{Reserves}} \quad (u'(c') + \xi'\Delta)}^{\text{Mg. utility benefts}} - \quad \overbrace{\underbrace{[\delta + (1-\delta)q']}_{\text{Debt repayments}}(1-d')(u'(c') + \xi'\Delta))}^{\text{Mg. utility costs}} \right\}$$

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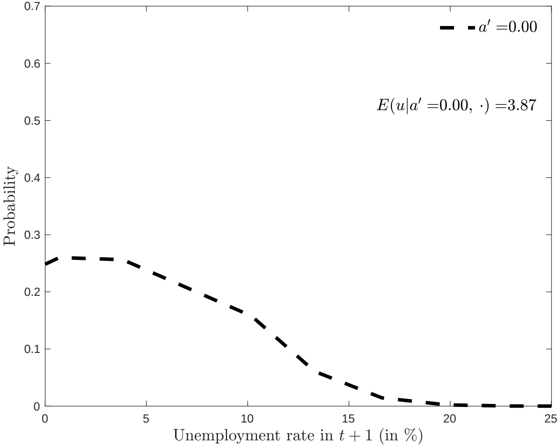
- Reserves pay-off in all states $\rightarrow$ high marginal value when unemployment is high $\Rightarrow$ macroeconomic stabilization
- Debt repayments relatively less costly in bad times (when q' is low)

Benefits of reserve accumulation

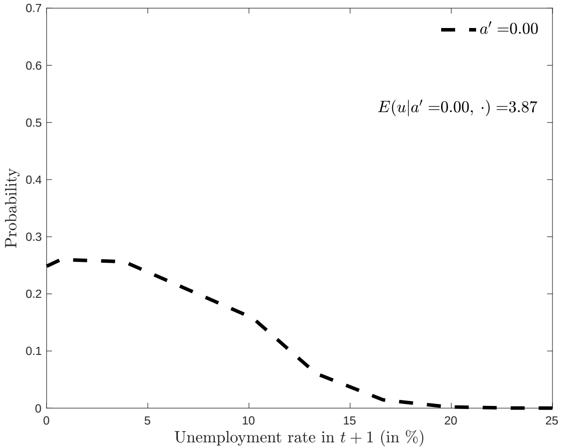
- We want to highlight two benefits of reserves.

- Exercise:
    1. Fix a point in the s.s. $\rightarrow \bar{c}$.
    2. Look at alternative a', and find b' that ensures $c = \bar{c}$.
    3. Show:
        3.1 Higher reserves can reduce future unemployment.
        3.2 Reserve accumulation may not be costly.

Higher reserves can reduce future unemployment

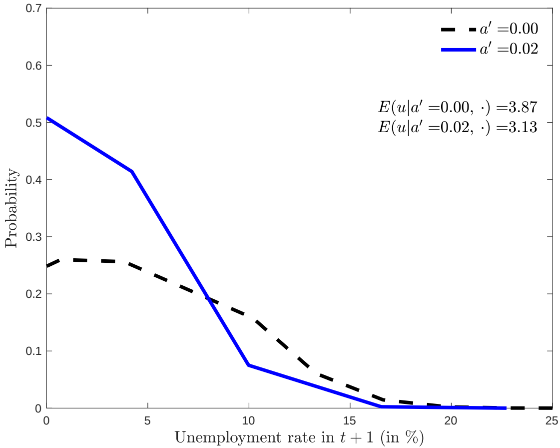


Higher reserves can reduce future unemployment



Now: consider a policy that issues debt to increase reserves, keeping current consumption constant.

Higher reserves can reduce future unemployment



Note: current consumption is constant across portfolios $\rightarrow$ higher reserves can reduce future unemployment.

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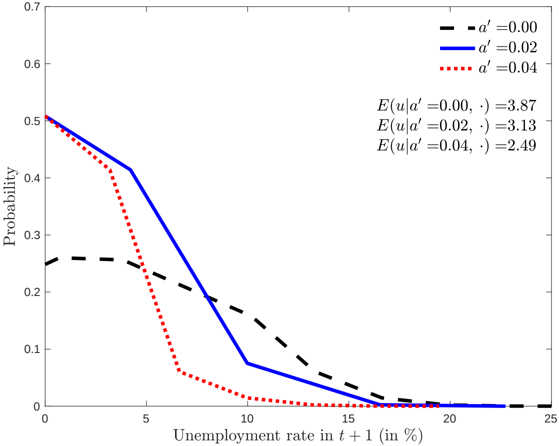

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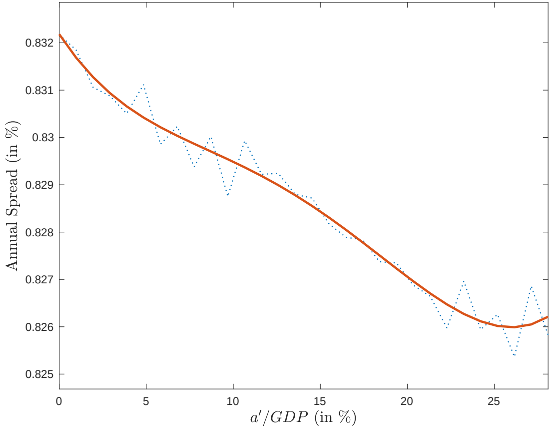
Reserves are not necessarily costly



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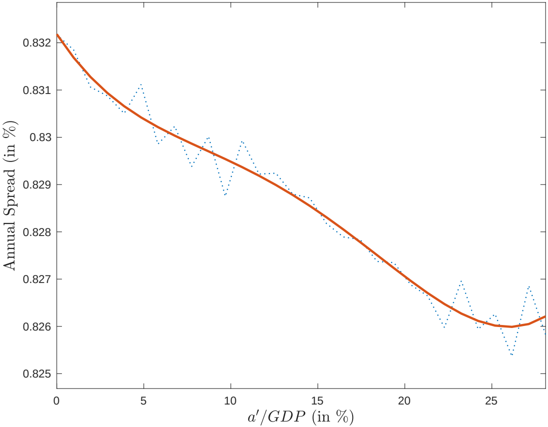

Note: $\exists\, a' > 0$ such that $Spread(a' > 0) \leqslant Spread(a' = 0)$.

Quantitative Analysis

- Calibrate to the average of a panel of 17 EMEs (1993–2014).
- Benchmark = economy with wage rigidity.
- 1 model period = 1 year.

Quantitative Analysis – Functional forms

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 (ctd)

Parameter	Description	Value
r	Risk-free rate	0.04
α	Labor share in NT sector	0.75
β	Domestic discount factor	0.90
π_{LH}	Prob. of transiting to high risk-premium	0.15
π_{HL}	Prob. of transiting to low risk-premium	0.8
σ_ϵ	Std. dev of innovation to $log(y^T)$	0.034
ρ	Autocorrelation of $log(y^T)$	0.66
μ_y	Mean of $log(y^T)$	$-\frac{1}{2}\sigma_\epsilon^2$
δ	Coupon decaying rate	0.2845
$1/(1+\mu)$	Intratemporal elast. of subs.	.44
γ	Coefficient of relative risk aversion	2.273
$\bar{h}$	Time endowment	1
	Parameters set by simulation	
ω	Share of tradables	0.3
g	Government consumption	0.25
ψ_0	Default cost parameter	2.4
ψ_1	Default cost parameter	19.5
κ	Pricing kernel parameter	22.5
$\bar{w}$	Lower bound on wages	0.8

Results

1. Simulations moments.
2. Default sets and spreads.
3. Welfare exercises.

Results: data and simulation moments

	Data	Model Benchmark
Targeted		
Mean debt (b/y)	42.0	42.5
Mean r_s	2.2	2.4
Δr_s w/ risk-prem. shock	2.0	2.0
Δ UR around crises	3.0	3.0
Mean g/y	12	12
Mean y^T/y	45	47
Non-Targeted		
$\sigma(c)/\sigma(y)$	1.1	1.1
$\sigma(r_s)$ (in %)	2.7	2.0
$\rho(r_s, y)$	-0.4	-0.7
$\rho(c, y)$	0.8	1.0
Mean Reserves (a/y)	16	17.9
Mean Reserves/Debt (a/b)	36	37.4

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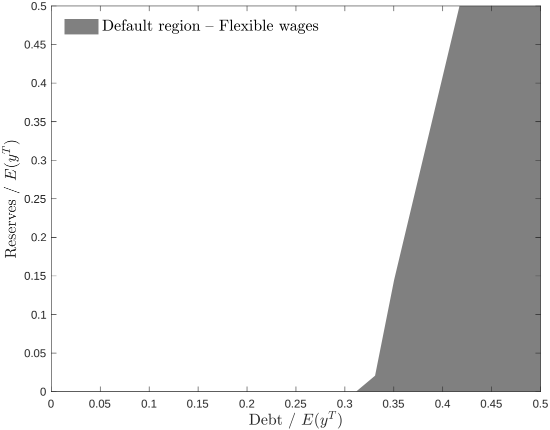
Δ UR around crises	3.0	3.0	0.0
Mean g/y	12	12	11
Mean y^T/y	45	47	44
Non-Targeted			
$\sigma(c)/\sigma(y)$	1.1	1.1	1.2
$\sigma(r_s)$ (in %)	2.7	2.0	1.8
$\rho(r_s, y)$	-0.4	-0.7	-0.9
$\rho(c, y)$	0.8	1.0	1.0
Mean Reserves (a/y)	16	17.9	3.6
Mean Reserves/Debt (a/b)	36	37.4	8.1

▸ full table

Results: default regions



- Default incentives **increase** in debt and **decrease** in reserves.

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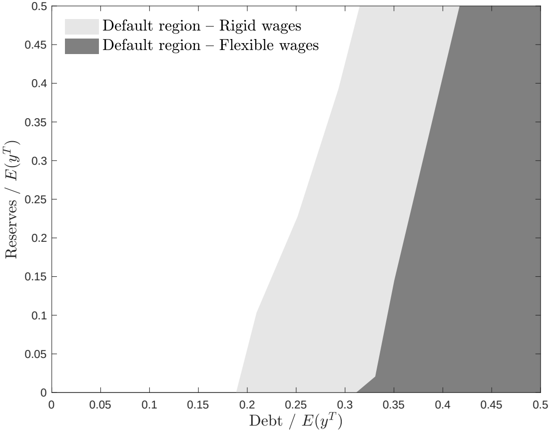

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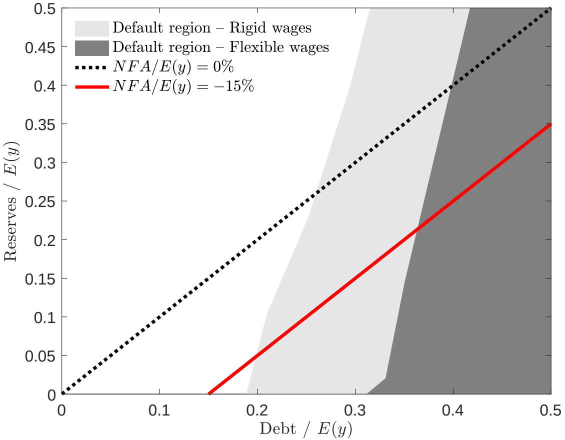
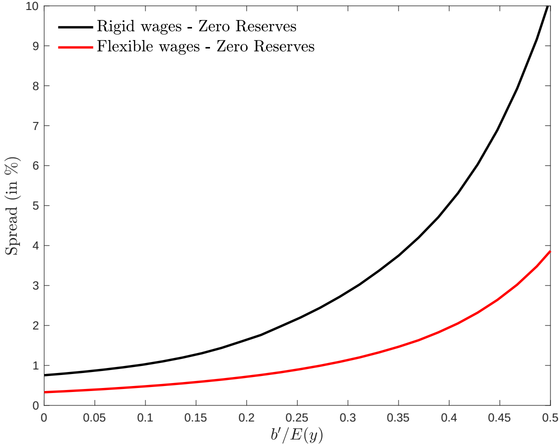
- Wage rigidity **increases** default incentives

Results: default regions and NFA



- Default incentives **increase** in debt and **decrease** in reserves.
- Wage rigidity **increases** default incentives
- Gross positions matter for default.

Results: spreads, reserves and wage rigidity



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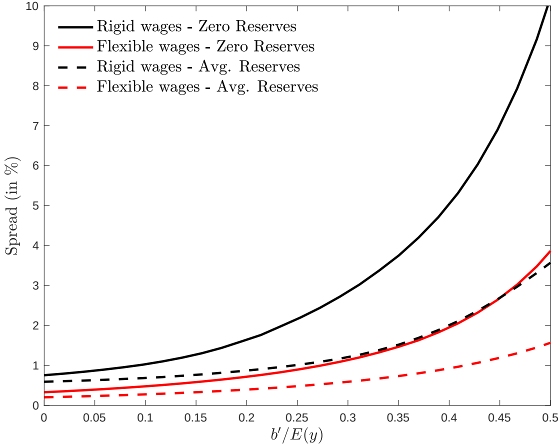
Results: spreads, reserves and wage rigidity



- Wage rigidity **increases** spreads.
- Reserves **decrease** spreads, and **more** when wages are rigid.

Results: welfare

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

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

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We're interested in studying:

- Gains of eliminating wage rigidity
- Gains of having access to reserves

To do this: define a "No-Reserves" economy (which can have or not wage rigidity).

Results: welfare

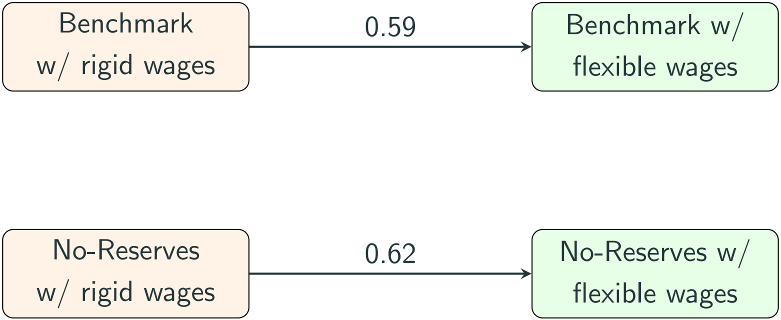
Benchmark
w/ rigid wages

Benchmark w/
flexible wages

No-Reserves
w/ rigid wages

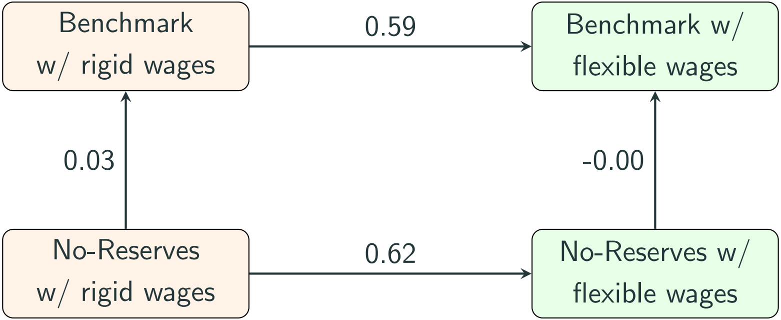
No-Reserves w/
flexible wages

Results: welfare



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

Results: welfare



- Eliminating wage rigidity is **welfare enhancing**, and more so when **reserve accumulation is not possible**.
- Being able to accumulate reserves is **welfare enhancing** when facing **wage rigidities**.

Conclusions

- Studied use of foreign reserves for macro stabilization goals in a SOE with:
    1. nominal rigidities
    2. fixed exchange rates, and
    3. sovereign default risk
- When borrowing costs are high, aggregate demand contracts causing involuntary unemployment
- Holdings of reserves (liquid assets) allow to mitigate fall in demand and increase in unemployment
- In good times, government issues debt and buy reserves for macroeconomic stabilization

Conclusions (ctd)

We found that:

- Mechanism is **quantitatively relevant**:
  - Avg. reserves/GDP are 14pp larger.
  - Avg. reserves/debt ratio is 29pp larger.
- Wage rigidity increases default incentives and spreads.
- Reserves decrease default incentives and spreads.
- **Reserves** help **reduce** future **unemployment risk** and need **not be costly**.
- There are **welfare gains** of accumulating reserves and eliminating wage rigidities.

Conclusions (ctd)

Other implications:

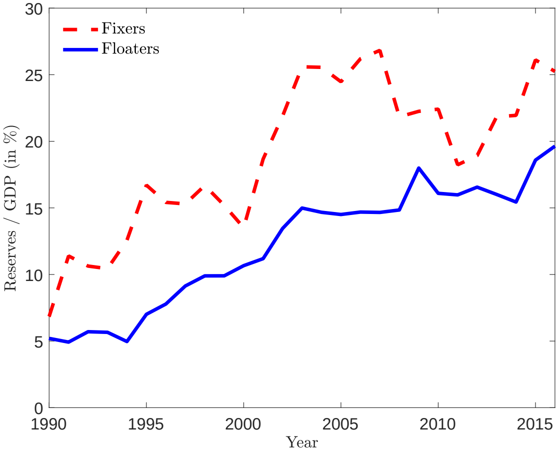
- Maastrict clauses establish limits for gross debt positions in Eurozone.
- Analysis suggests that minimum holdings of assets could be a good idea.
    - A stock of foreign reserves might mitigate temptations to exit.

THANKS !

Reserve accumulation

▸ (back)

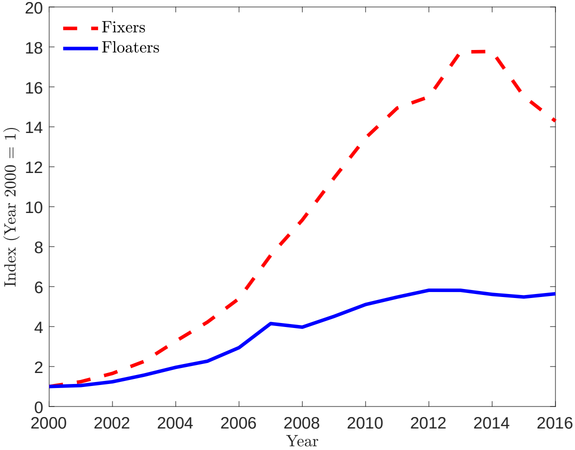
EMEs with fixed exchange rates hold more foreign reserves ...



Reserve accumulation

(back)

... and have accumulated reserves faster.



Reserve accumulation – Regressions

(back)

Variables	(1) Reserves/GDP	(2) Reserves/GDP
IMF ERR	**-0.0368*****	
	(0.00564)	
Ilzetzki-Reinhart-Rogoff ERR		**-0.0116*****
		(0.00396)
year	0.00560***	0.00561***
	(0.000475)	(0.000487)
Constant	-10.95^{***}	-11.05^{***}
	(0.951)	(0.976)
Observations	614	614
R-squared	0.229	0.187

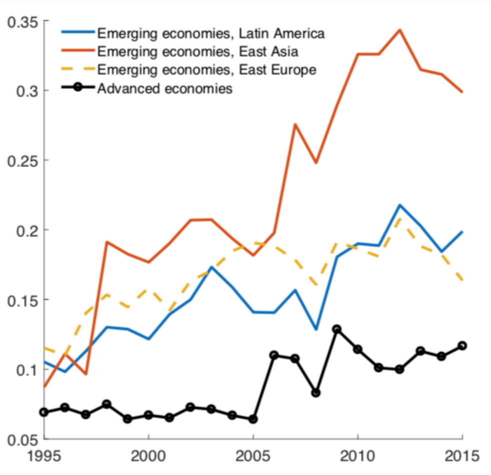
Table 1: Regressions. Standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Data for MSCI Emerging Market countries from 1990 to 2016. Higher ERR means more flexibility exchange rate regimes.

Reserves around the world

(back)

Over the past 20 years massive increase in foreign reserves holdings by Central Banks around the world



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

Countries in our dataset

(back)

We use the IMF Classif. of Exch. Rate Arrangements (as of 2016)

We follow Kondo and Hur (2016) and focus on 23 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	Philippines	

Table 2: EME classification: follow Financial Times and the London Stock Exchange (FTSE), Morgan Stanley Capital International (MSCI), the Economist, Standard & Poor's (S&P), and Dow Jones Indexes.

More simulations

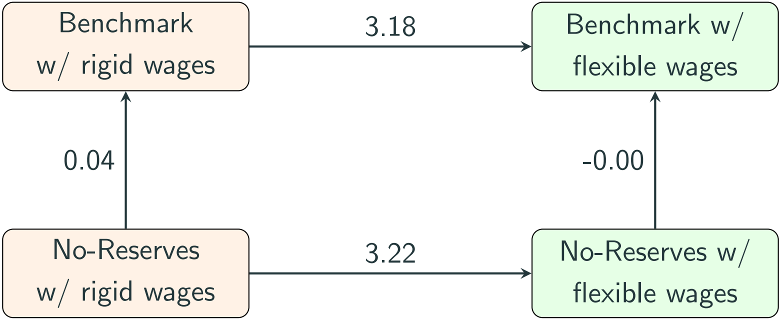
(back)

	Data	Model Benchmark	Model Flexible w	Model Flexible w (no recal.)
Targeted				
Mean debt (b/y)	42.0	42.5	42.0	61.2
Mean r_s	2.2	2.4	2.2	3.0
Δr_s w/ risk-prem. shock	2.0	2.0	1.9	2.6
Δ UR around crises	3.0	3.0	0.0	0.0
Mean g/y	12	12	11	13
Mean y^T/y	45	47	44	50
Non-Targeted				
$\sigma(c)/\sigma(y)$	1.1	1.1	1.2	1.3
$\sigma(r_s)$ (in %)	2.7	2.0	1.8	2.4
$\rho(r_s, y)$	-0.4	-0.7	-0.9	-0.9
$\rho(c, y)$	0.8	1.0	1.0	1.0
Mean Reserves (a/y)	16	17.9	3.6	5.4
Mean Reserves/Debt (a/b)	36	37.4	8.1	8.8

Results: welfare

(back)

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



Results: welfare gains of eliminating wage rigidity

▸ (back)

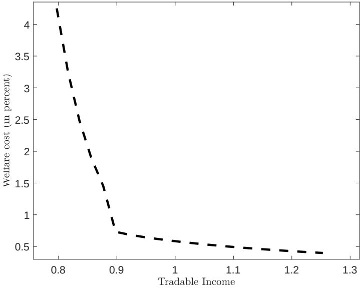


Figure 1: Benchmark

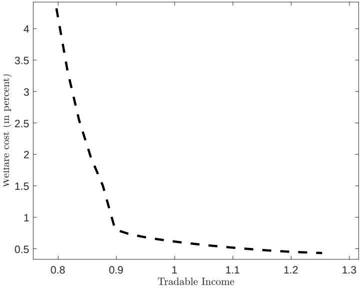


Figure 2: No-Reserves

Spreads w/ and w/o access to reserve accumulation

(back)

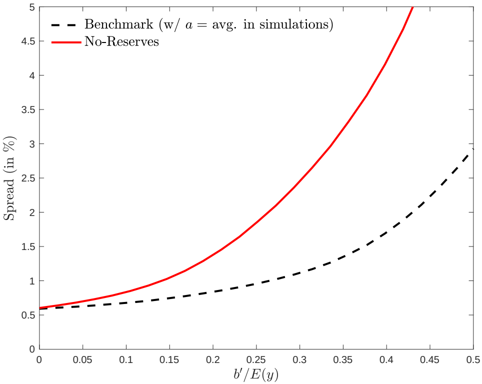


Figure 3: Spreads with and without access to reserves.