Reserve Accumulation, Macroeconomic Stabilization and Sovereign Risk

Javier Bianchi[1] César Sosa-Padilla[2]

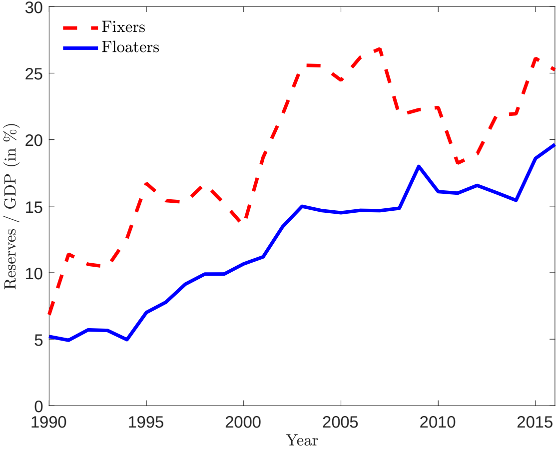
2018 SED Annual Meeting

[1]Minneapolis Fed & NBER

[2]University of Notre Dame

Motivation

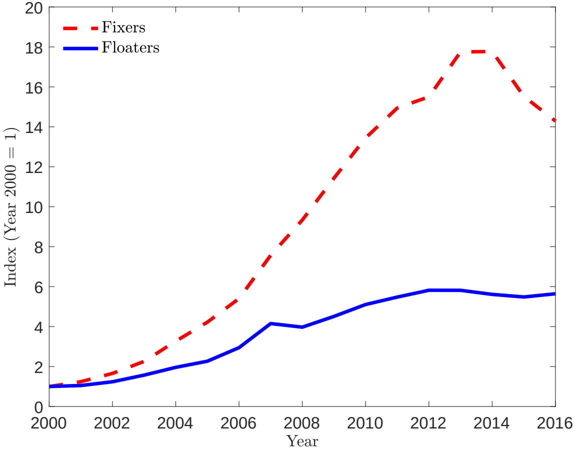
EMEs with fixed exchange rates hold more foreign reserves ...



data details

Motivation (ctd)

... and have accumulated reserves faster.



▸ data details

Motivation (ctd)

- Adoption of fixed or quasi-fixed exchange rate is prevalent

Motivation (ctd)

- Adoption of fixed or quasi-fixed exchange rate is prevalent
- Share of countries w/ less flexible exchange rates 60% – 80% (Ilzetzki et. al. 2017)

Motivation (ctd)

- Adoption of fixed or quasi-fixed exchange rate is prevalent
- Share of countries w/ less flexible exchange rates 60% – 80% (Ilzetzki et. al. 2017)
- Has gone up w/ adoption of Euro among Adv. Economies

Motivation (ctd)

Conventional view: central banks w/ fixed exchange rate hold more reserves to prevent speculative attacks on currencies (Krugman)

- With higher reserves, less need to resort to inflation tax to make up for inconsistent fiscal/monetary policy.

Motivation (ctd)

Conventional view: central banks w/ fixed exchange rate hold more reserves to prevent speculative attacks on currencies (Krugman)

- With higher reserves, less need to resort to inflation tax to make up for inconsistent fiscal/monetary policy.

In practice, however, central banks can also borrow to avoid resorting to inflation tax

Motivation (ctd)

Conventional view: central banks w/ fixed exchange rate hold more reserves to prevent speculative attacks on currencies (Krugman)

- With higher reserves, less need to resort to inflation tax to make up for inconsistent fiscal/monetary policy.

In practice, however, central banks can also borrow to avoid resorting to inflation tax

In this paper, we explore an alternative channel linking precautionary motives and macroeconomic stabilization

Motivation (ctd)

Conventional view: central banks w/ fixed exchange rate hold more reserves to prevent speculative attacks on currencies (Krugman)

- With higher reserves, less need to resort to inflation tax to make up for inconsistent fiscal/monetary policy.

In practice, however, central banks can also borrow to avoid resorting to inflation tax

In this paper, we explore an alternative channel linking precautionary motives and macroeconomic stabilization

- Show that this is a quantitatively important channel to explain observed levels of reserves.

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) allow to mitigate fall in demand and increase in unemployment
- In good times, government issues debt and buy reserves for macroeconomic stabilization

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 $\phi(y)$
- Risk averse foreign lenders $\rightarrow$ "risk-premium shocks"

Households

- Households' preferences over consumption

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

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

- Budget constraint in units of tradables

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

Households

- Households' preferences over consumption

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

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

- Budget constraint in units of tradables

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

- 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

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

- w_t: price of non-tradables and wages in units of tradables
- Firms' optimality condition is

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

Firms

- Maximize profits given by

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

- w_t: price of non-tradables and wages in units of tradables
- Firms' optimality condition is

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

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

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
- Risk-free asset pays one unit of consumption
  - price is q_a

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
- 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)

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

- Implies constant risk free rate:

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

- Bond price given by:

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

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

Foreign Investors

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

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

- Implies constant risk free rate:

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

- Bond price given by:

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

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

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

Recursive Problem

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

Recursive Problem

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

Value of repayment:

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

subject to

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

Recursive Problem (ctd)

Value of default:

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

subject to

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

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:

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

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:

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

Equilibrium employment:

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

Optimality Conditions – Labor Market

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

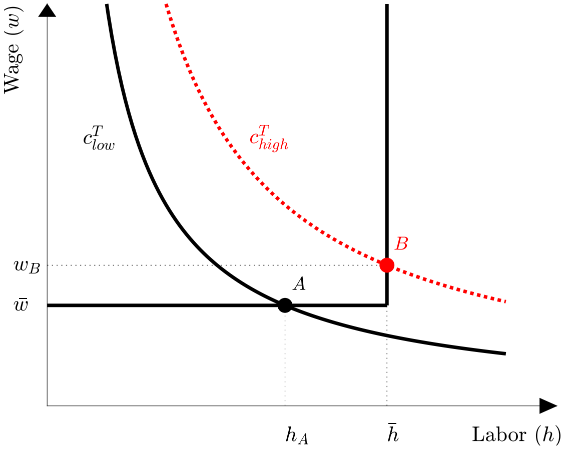
Optimality in labor market implies:

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

Equilibrium employment:

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

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

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

Tradable consumption has 2 benefits:

1. direct utility
2. reduction of unemployment

Optimality Conditions

FOC wrt c^T:

$$c^T : \quad u_T + \xi \quad \Delta \qquad\qquad\qquad\qquad = \lambda$$

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

Tradable consumption has 2 benefits:

1. direct utility
2. reduction of unemployment

Optimality Conditions

FOC wrt c^T:

$$c^T: \quad u_T + \xi \quad \Delta \qquad\qquad\qquad = \lambda$$

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

Tradable consumption has 2 benefits:

1. direct utility
2. reduction of unemployment

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:

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

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:

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

The future marginal benefit of doing this is:

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

- Reserves pay-off in all states $\rightarrow$ high marginal value when unemployment is high $\Rightarrow$ macroeconomic stabilization

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:

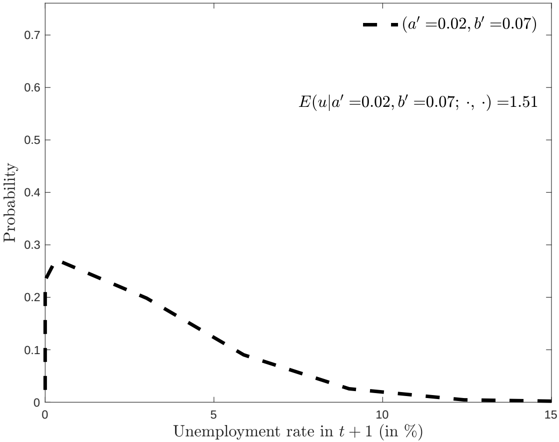
$$\tilde{a} = \frac{q(\tilde{a}, b', s) + \frac{\partial q(\tilde{a}, b', s)}{\partial b'}}{q_a - \frac{\partial q(\tilde{a}, b', s)}{\partial a'}}.$$

The future marginal benefit of doing this is:

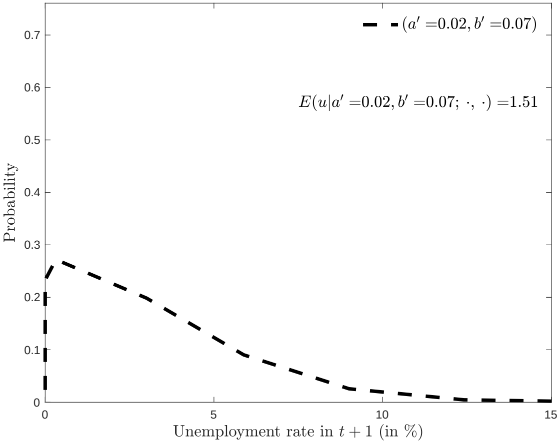
$$\mathbb{E}_{s'|s}\left\{ \overbrace{\underbrace{\partial \tilde{a}}_{\text{Reserves}} \quad (u'(c') + \xi'\Delta)}^{\text{Mg. utility benefts}} - \overbrace{\underbrace{[\delta + (1-\delta){\color{orange}q'}]}_{\text{Debt repayments}}(1-d')(u'(c') + {\color{orange}\xi'}\Delta))}^{\text{Mg. utility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

- 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)

Higher reserves can reduce future unemployment

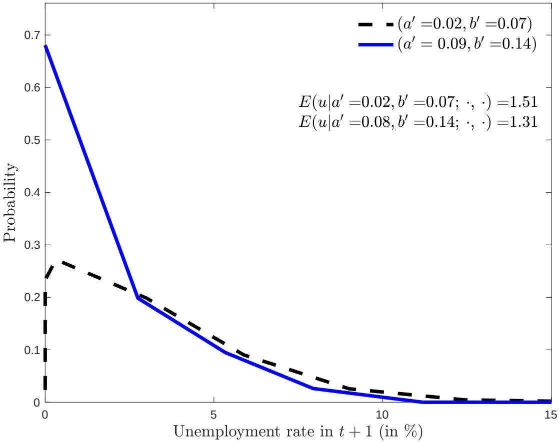


Higher reserves can reduce future unemployment



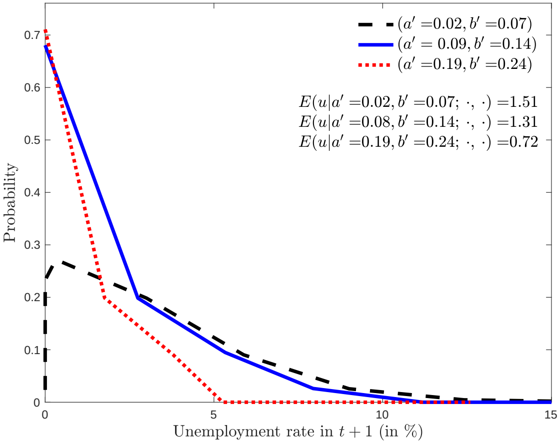
Now: consider a policy that issues debt to increase reserves, keeping NFA constant.

Higher reserves can reduce future unemployment



Note: NFA is constant across portfolios $\rightarrow$ higher reserves can reduce future unemployment

Higher reserves can reduce future unemployment



Note: NFA is constant across portfolios $\rightarrow$ higher reserves can reduce future unemployment

Quantitative Analysis

- Today: Calibrate flexible wage economy (Bianchi, Hatchondo and Martinez) and show effects of wage rigidity.

- 1 model period = 1 year.

- Use Mexican data (archetypical EME).

Quantitative Analysis – Functional forms

Utility function:

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

Utility cost of defaulting:

$$\psi_d(y^T) = \alpha_0 + \alpha_1 log(y^T)$$

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
β	Domestic discount factor	0.92
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 $log(y^T)$	$-\frac{1}{2}\sigma_\epsilon^2$
g	Government consumption	0.12
δ	Coupon decaying rate	0.2845
ω	Share of tradables	0.3
$1+\mu$	Inverse of the intratemporal elast. of subs.	γ
	Parameters set by simulation	
α_0	Default cost parameter	2.45
α_0	Default cost parameter	19
κ_H	Pricing kernel parameter	23
γ	Coefficient of relative risk aversion	3.3
$\bar{w}$	Lower bound on wages	1.25

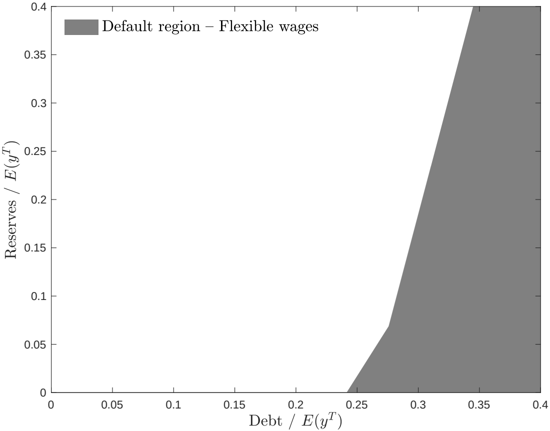
Results

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

Results: data and simulation moments

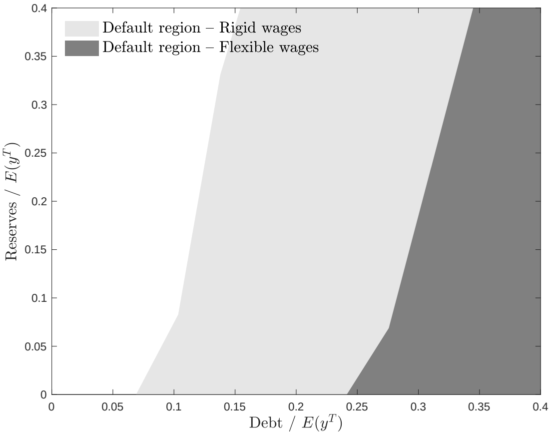
	Data	Model	
		Flex. w	Rigid w
Targeted			
$\sigma(c)/\sigma(y)$	1.0	1.0	1.0
Mean debt (b/y^T)	43.0	44.6	17.1
Mean r_s	2.4	2.5	2.4
Δr_s w/ risk-prem. shock	2.0	2.0	1.6
Non-Targeted			
$\sigma(r_s)$	0.9	2.0	1.9
$\rho(r_s, y)$	-0.5	-0.8	-0.8
$\rho(c, y)$	0.8	0.9	0.9
Mean Reserves (a/y^T)	8.5	7.3	14.4
Mean Reserves/Debt (a/b)	0.20	0.17	0.85
Unemployment	3.9	0.0	2.8

Results: default regions



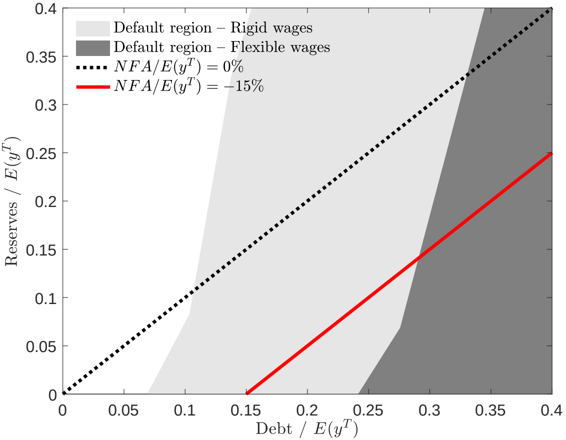
- Default incentives **increase** in debt and **decrease** in reserves.

Results: default regions



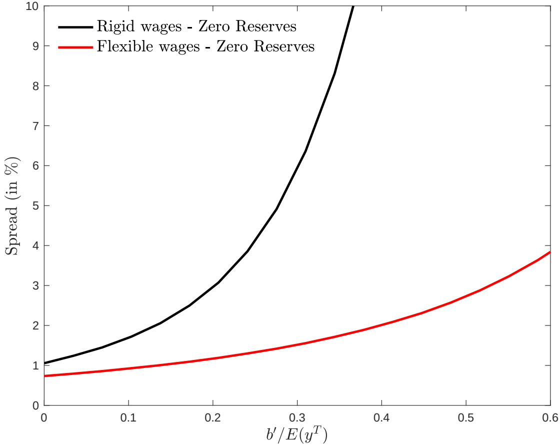
- Default incentives **increase** in debt and **decrease** in reserves.
- Wage rigidity **increases** default incentives

Results: default regions and NFA



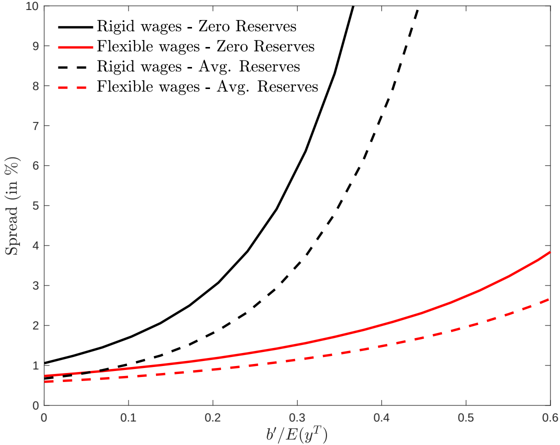
- Default incentives **increase** in debt and **decrease** in reserves.
- Wage rigidity **increases** default incentives
- Gross positions matter for default.

Results: spreads, reserves and wage rigidity



- Wage rigidity increases spreads.

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:

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

We're interested in studying:

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

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

Results: welfare gains of eliminating wage rigidity

Baseline	**Alternative**	**Welf. Gain**
Benchmark w/ wage rigidity	Benchmark w/ flexible wage	2.48
No-Reserves w/ wage rigidity	No-Reserves w/ flexible wage	4.80

- Eliminating wage rigidity is **welfare enhancing**.
- Even **more** when **reserve accumulation is not possible**.

plots

Results: welfare gains of access to reserve accumulation

Baseline	**Alternative**	**Welf. Gain**
No-Reserves w/ flexible wage	Benchmark w/ flexible wage	0.15
No-Reserves w/ wage rigidity	Benchmark w/ wage rigidity	2.41

- Being able to accumulate reserves is **welfare enhancing**.
- Even **more** when facing **wage rigidities**.

▸ plots

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 are twice as large.
  - Avg. reserves/debt ratio is 4 times as large.
- Wage rigidity increase default incentives and spreads.
- Reserves decrease default incentives and spreads.
- **Reserves** help **reduce** future **unemployment risk**.
- There are **sizeable 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 should be established.

    - A stock of foreign reserves might mitigate temptations to exit

THANKS !

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 1: 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.

Welfare gains of eliminating wage rigidity

(back)

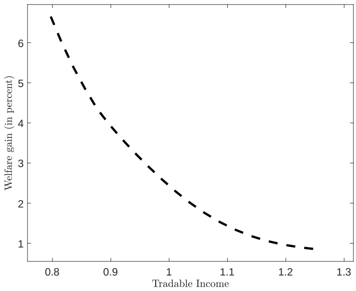


Figure 1: Benchmark

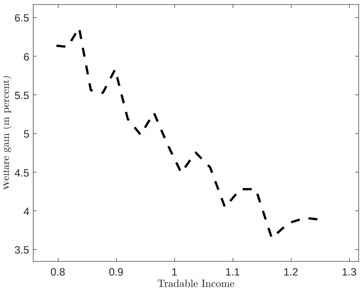


Figure 2: No-Reserves

Welfare gains of access to reserve accumulation

(back)

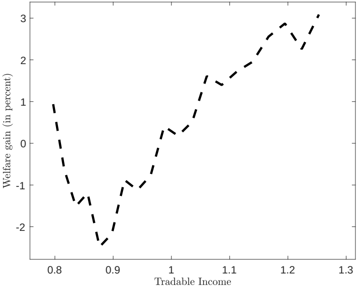


Figure 3: Flexible wages

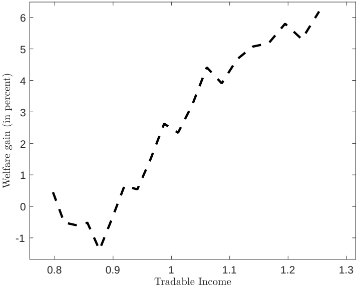


Figure 4: Rigid wages

Results: welfare gains of eliminating wage rigidity

Initial debt = Avg. in simulations (14%). Initial reserves= zero.

Baseline	**Alternative**	**Welf. Gain**
Benchmark w/ wage rigidity	Benchmark w/ flexible wage	3.31
No-Reserves w/ wage rigidity	No-Reserves w/ flexible wage	4.81

- Eliminating wage rigidity is **welfare enhancing**.
- Even **more** when **reserve accumulation is not possible**.

Results: welfare gains of access to reserve accumulation

Initial debt = Avg. in simulations (14%). Initial reserves= zero.

Baseline	**Alternative**	**Welf. Gain**
No-Reserves w/ flexible wage	Benchmark w/ flexible wage	-0.32
No-Reserves w/ wage rigidity	Benchmark w/ wage rigidity	1.12

- Being able to accumulate reserves can be **welfare enhancing**, especially with **wage rigidities**.

Welfare gains of eliminating wage rigidity

▸ (back)

Initial debt = Avg. in simulations (14%). Initial reserves= zero.

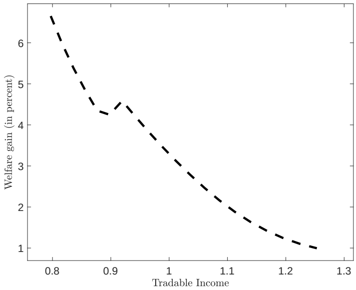


Figure 5: Benchmark

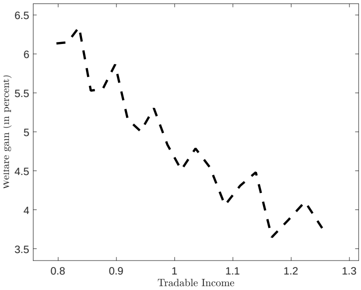


Figure 6: No-Reserves

Welfare gains of access to reserve accumulation

(back)

Initial debt = Avg. in simulations (14%). Initial reserves= zero.

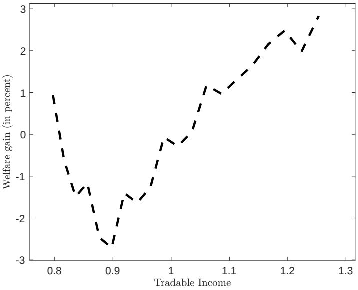


Figure 7: Flexible wages

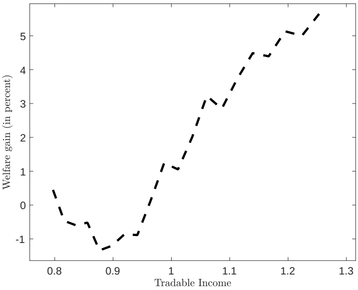


Figure 8: Rigid wages