On the Optimal Design of a *Financial Stability Fund*

Forthcoming at *Review of Economic Studies*

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Big picture of the research agenda

> *The political problem of mankind is to combine three things: Economic Efficiency, Social Justice, and Individual Liberty.*
>
> J. M. Keynes, 1926, *Essays in Persuasion*

The general theme: constrained efficient mechanism

1. 'On the Optimal Design of Financial Stability Fund,' Árpád Ábrahám, Eva Carceles-Poveda, **Yan Liu**, and Ramon Marimon (forthcoming, *RES*)
2. 'Making Sovereign Debt Safe with a Financial Stability Fund,' **Yan Liu**, Ramon Marimon and Adrien Wicht (2023, *JIE*)
3. 'On a Lender of Last Resort with a Central Bank and a Stability Fund,' Giovanni Callegari, Ramon Marimon, Adrien Wicht and Luca Zavalloni (2023, *RED*)
4. 'On the Optimal Design of a Fiscal and Currency Union,' Alessandro Ferrari, **Yan Liu**, Ramon Marimon, Chima Simpson-Bell (in progress)

Financial stabilization dealing with the Euro Debt crisis: 4 related themes

I. **Risk-sharing and stabilization policies in normal times**
II. **Dealing with severe crises** (a robust crisis management mechanism)
III. **Resolving a debt crisis** (the euro 'debt overhang')
IV. **Developing 'safe assets'**

Financial stabilization: our approach

Concentrate on

I. **Risk-sharing and stabilization policies in normal times**

by solving for a

Financial Stability Fund **as a constrained efficient risk-sharing mechanism**

Financial stabilization: our approach

Concentrate on

I. **Risk-sharing and stabilization policies in normal times**

by solving for a

***Financial Stability Fund* as a constrained efficient risk-sharing mechanism**

also helps to:

II. **Dealing with severe crises**,

III. **Resolving a debt crisis**, and

IV. **Developing 'safe assets'**

Designing the *Financial Stability Fund*

A long-term, self-enforcing, partnership, between the Fund and a member country

- Can provide risk sharing and enhance borrowing & lending and investment opportunities
- With *ex post* contingent transfers, in contrast to unconditional debt contracts, perhaps with *ex ante* eligibility conditions ('austerity programs')
- Normal-times-transfers 'build trust', in contrast with crisis-relief-transfers which tend to create 'stigma & resentment'
- More counter-cyclical fiscal policies (address time-inconsistency problems in fiscal policies)

Designing the *Fund* accounting for 3+2 constraints

- The sovereignty constraint: the country can always 'exit,' although may be costly
  - Borrower's limited enforcement constraint
- The redistribution constraint: risk-sharing transfers should not become ex-post persistent, or permanent (Hayek's problem)
  - Lender's limited enforcement constraint
  - Make the Fund genuinely recursive
- The moral hazard constraint: the severity of shocks may depend on which policies and reforms are implemented

Designing the *Fund* accounting for 3+2 constraints

- The asymmetry constraint: there may not be an ex-ante ‘veil of ignorance’ and countries may start with large (debt) liabilities
- The funding constraint: the fund should be (mostly) self-funded

Overview of the work

A *quantifiable* theory on the design of a financial stability fund

- Optimal financial stability fund (Fund):
  recursive contract approach, accounting for MH constraint
  - Existence (and uniqueness), & implementation
- Incomplete market with default (IMD) and moral hazard:
  calibration and benchmark for comparison
- Quantitative comparison of IMD with Fund

The environment

- One risk-averse government (borrower) & one risk-neutral fund (lender)
- Lender: access to funds at the risk-free rate r
- Borrower's output: $y = \theta f(n)$
- Borrower's preferences: $U(c, n, e) \equiv u(c) + h(1 - n) - v(e)$ & β, $1/(1 + r) \geq \beta$
- Markovian shocks: productivity, θ & government expenditure, $g = g^c + g^d$; i.e. an exogenous state $s = (\theta, g^d, g^c)$, with transition probability $\pi(s'|s, e)$
- Governmental effort, e, decreases the probability of high government expenditure g^c; g^d is iid (for technical reason)

Two alternative borrowing & lending mechanisms

1. *Incomplete markets* with default (IMD), where
   - countries smooth shocks, and borrow and lend, with long-term non-contingent debt;
   - there can be default (full, in our case);
   - default is costly and the country has no access to international financial markets, temporarily

Two alternative borrowing & lending mechanisms

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2. *Financial Stability Fund* (Fund), where
   - a country could leave the Fund at any time, but it is not in her interest to do so;
   - persistent transfers are limited by the amount of redistribution that is mutually accepted;
   - there are incentives for countries to apply policies which reduce risks (not in our current simulations)

Incomplete market with default: Long-term bond

Following Chaterjee and Eyigungor (2012), a long-term bond is parameterized by (δ, κ), where

- δ is the probability of continuing to pay out coupon in the current period;
- $(1 - \delta)$ is the probability of maturing in the current period (i.e $\delta = 0$ is one-period debt);
- κ is the coupon rate (possibly $\kappa = 0$);
- **Assumption**: unit bonds are infinitely small $\Longrightarrow$ $(1 - \delta)$ fraction of maturing bond portfolio

Given a constant discount rate r, and no default risk, the price of a unit bond equals to

$$q = \sum_{t=0}^{\infty} [(1 - \delta) + \delta\kappa] \frac{\delta^t}{(1 + r)^{t+1}} = \frac{(1 - \delta) + \delta\kappa}{1 - \delta + r}$$

Incomplete market with default: recursive formulation

If a borrower does not default on her outstanding debt, $(-b)$, in state s, the value of the 'debt contract' is:

$$V_n^{bi}(b,s) = \max_{c,n,e,b'} U(c,n,e) + \beta\mathbb{E}\left[V^{bi}(b',s')\middle|s,e\right]$$
$$\text{s.t.} \quad c + g + q(s,b,b')(b' - \delta b) \leq \theta f(n) + (1 - \delta + \delta\kappa)b,$$

where, taking into account that default can occur next period,

$$V^{bi}(b,s) = \max\{V_n^{bi}(b,s), V^{ai}(s)\}$$

Assumption: Effort e, is not observable/contractable by the market
Positive spread: $r(s,b,b') \geq r \Leftrightarrow q(s,b,b') \leq q$, because of default risk by borrower

Incomplete market with default: autarky

- The value in autarky is given by

$$V^{ai}(s) = \max_{n,e} u(\theta_p(\theta) f(n) - g) + h(1-n) - v(e) + \beta \mathbb{E}\left[(1-\lambda)V^{ai}(s') + \lambda V^{bi}(0, s') \middle| s, e\right]$$

- Default penalty: a drop in productivity, from θ to $\theta_p(\theta)$
- After default a government is in autarky, but can re-enter the financial (incomplete) market with probability λ

Financial Stability Fund: optimal long-term contract

- Use recursive contract theory (Marcet & Marimon 2019) to characterize the optimal contract between borrower and lender, which is subject to:

  intertemporal participation constraints to guarantee that none of the agents wants to quit when there are still joint gains to be shared

  moral hazard constraints to guarantee that effort to reduce risks is made
- Transfers are conditional on: (i) the state of economy, and (ii) the past history of the agents in the Fund: a single statistic (the relative Pareto weights of the Planner's problem) summarizes the history as a co-state

Financial Stability Fund: setup

$$\max_{\{c,n,e\}} \mathbb{E}\left\{ \sum_{t=0}^{\infty} \left[\mu_{b,0}\beta^t U(c(s^t), n(s^t), e(s^t)) + \mu_{l,0}\left(\frac{1}{1+r}\right)^t c_l(s^t) \right] \middle| s_0 \right\}$$

$$\text{s.t.} \quad \mathbb{E}\left[\sum_{j=t}^{\infty} \beta^{j-t} U(c(s^j), n(s^j), e(s^j)) \middle| s^t \right] \geq V^{af}(s_t), \tag{P$_b$}$$

$$v'(e(s^t)) = \beta \sum_{s^{t+1}|s^t} \pi^{\theta}(\theta_{t+1}|\theta_t) \frac{\partial \bar{\pi}^g(g_{t+1}|g_t, e(s^t))}{\partial e(s^t)} V^{bf}(s^{t+1}), \tag{IC}$$

$$\mathbb{E}\left[\sum_{j=t}^{\infty} \left(\frac{1}{1+r}\right)^{j-t} c_l(s^j) \middle| s^t \right] \geq Z, \tag{P$_l$}$$

$\forall\, t \geq 0, s^t$, with $\mu_{b,0}, \mu_{l,0}$ given

and $c_l(s^t) = \theta_t f(n(s^t)) - g_t - c(s^t)$

Financial Stability Fund: recursive contract formulation

Following Marcet and Marimon (2019) and Mele (2013): with $\eta = \beta(1+r)$,

$$
\begin{aligned}
FV(x,s) = \text{SP} \min_{\{\nu_b,\nu_l,\tilde{\xi}\}} \max_{\{c,n,e\}} \quad & x\Big((1+\nu_b)U(c,n,e) - \tilde{\xi}v'(e) - \nu_b V^{af}(s)\Big) \\
& + \Big((1+\nu_l)(\theta f(n) - g - c) - \nu_l Z\Big) \\
& + \frac{1+\nu_l}{1+r}\mathbb{E}\Big[FV(x',s')\Big|s,e\Big] \\
\text{s.t.} \quad & x' = \frac{1+\nu_b+\varphi'}{1+\nu_l}\eta x \text{ and } \varphi' = \tilde{\xi}\frac{\partial_e \bar{\pi}^g(g'|g,e)}{\bar{\pi}(g'|g,e)}
\end{aligned}
$$

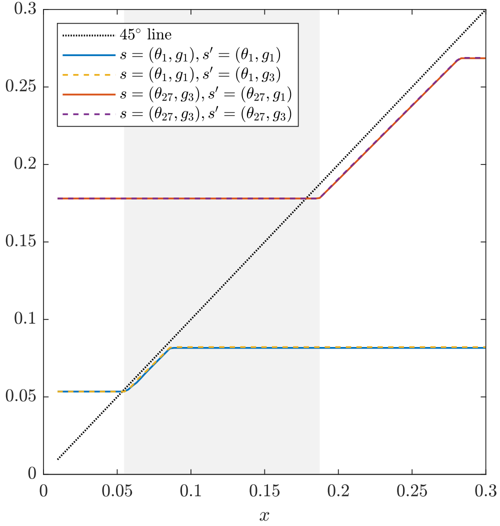
Proposition

Under standard regularity conditions, the optimal fund contract exists and is unique.

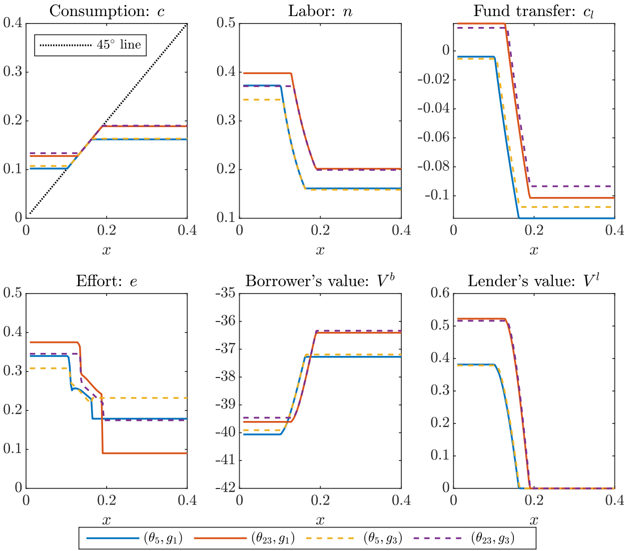
Remark

The main breakthrough is a proof that the maximand is concave in e

Characterization of the Fund dynamics



Characterization of the Fund allocation



Decentralization: borrower

One particular implementation for the Fund
A complete set of long-term contingent securities, with maturity structure identical to the IMD setup

$$W^b(a_b, s) = \max_{c_b, n, e, a'_b(s')} U(c_b, n, e) + \beta \mathbb{E}\left[W^b(a'_b, s') \middle| s, e\right]$$

$$\text{s.t. } c_b + \sum_{s'|s} q(s'|s)(a'(s')(1 + \tau^a(s')) - \delta a)$$
$$\leq \theta(s) f(n) - g(s) + (1 - \delta + \delta\kappa) a(s) + \overline{\tau}(s),$$
$$a'_b(s') \geq A_b(s')$$

- $\tau^a(s')$: asset holding taxes, with lump sum transfer $\overline{\tau}(s) = \sum_{s'|s} q(s'|s) a'_{as}(s') \tau^a(s')$ to make budget neutral
- $A_b(s')$: endogenous borrowing constraint

Decentralization: lender

Lender has access to the same set of contingent securities.

$$W^l(a_l, s) = \max_{\{c_l, a_l'(s')\}} c_l + \frac{1}{1+r}\mathbb{E}\left[W^l(a', s')\middle| s, e\right]$$

$$\text{s.t. } c_l + \textstyle\sum_{s'|s} q(s'|s)[a_l'(s') - \delta a_l(s)]$$

$$\leq (1 - \delta + \delta\kappa) a_l(s) p,$$

$$a_l(s') \geq A_l(s')$$

- $A_l(s')$: endogenous borrowing limit

Decentralization: endogenous borrowing limits

- The borrowing limits satisfy

$$W^b(A_b(s^t), s^t) = V^{af}(s^t)$$
$$W^l(A_l(s^t), s^t) = Z$$

- $Z \leq 0$ is also the amount of *ex post* redistribution that the Fund is willing to accept (e.g. $Z = 0$ provides limited, but positive, risk-sharing)

Decentralization: asset pricing

Let $\{c_b^*(s^t), n^*(s^t), c_l^*(s^t)\}$ be the allocation of the *Fund*.

$$q^*(s^{t+1}|s^t) = \bar{q}(s^{t+1}|s^t)\max\left\{\eta\frac{u'(c_b^*(s^{t+1}))}{u'(c_b^*(s^t))}\frac{1}{1+\tau^a(s')}, 1\right\},$$

with

$$\bar{q}(s^{t+1}|s^t) = \pi(s_{t+1}|s_t)\frac{(1-\delta+\delta\kappa)+\delta q^f(s^{t+1})}{1+r}$$

Price of long-term risk-free bond: $q^f(s^t) = \sum_{s_{t+1}|s_t} q^*(s^{t+1}|s^t)$, with implicit interest rate $r^f(s^t) = (1-\delta+\delta\kappa)/q^f(s^t) - (1-\delta)$

Negative spread: $r^f(s^t) - r \leq 0$ as $q^f(s^t) \geq q$

Decentralization

Proposition

The second welfare theorem holds in this economy, with asset holding taxes.

Proposition

The unconstrained first welfare theorem does not hold in this economy. A set of state contingent taxes on assets transactions is required to achieve the constrained efficiency.

Pin down the taxes to correct the externality associated with equilibrium effort under the moral hazard constraint:

$$\frac{1}{1+\tau^a(s')} = 1 + \chi(x,s)u'(c_b(x,s))\frac{\partial_e \pi(s'|s,e(x,s))}{\pi(s'|s,e(x,s))}$$

Parameter values

- Utility:

$$\log(c) + \gamma \frac{(1-n)^{1-\sigma} - 1}{1-\sigma} - \omega e^2, \quad \text{with } \sigma = 0.34, \gamma = 1.734, \omega = 0.1$$

  Production: $f(n) = n^{\alpha}$, with $\alpha = 0.566$
- Borrower's discount factor $\beta = 0.929$, while $r = 2.48\%$
- The probability of returning to the market in the IMD after default is $\lambda = 0.264$; default penalty

$$\theta^p(\theta) = \begin{cases} \psi\mathbb{E}\theta, & \theta \geq \psi\mathbb{E}\theta \\ \theta, & \theta < \psi\mathbb{E}\theta \end{cases} \quad \text{with } \psi = 0.189$$

- IMD long-term bond: $\delta = 0.814$, $\kappa = 8.3\%$
- **Tight** two-sided limited enforcement constraint (Fund) $Z = 0$
- Effort e: $\bar{\pi}^{g_c}(g_c'|g_c, e) = \zeta(e)\pi^l(g_c'|g_c) + (1-\zeta(e))\pi^h(g_c'|g_c)$, with $\zeta(e) = (1-e)^2$

Data and shock processes

- Annual data for GIPS countries over 1980–2015, main source: AMECO
- Construct labor productivity using aggregate working hours for each country; fit the productivity series with a panel Markov regime switching model; discretize the MS process into a 27-state Markov chain:
  Best state: $\theta_{27}, \ldots,$ worst state: θ_1
- Calibrate the g^c shock with a 3-state Markov chain, featuring persistent 'crisis' state:
  Best state: $g^c_3 \equiv g_3, \ldots,$ worst state: $g^c_1 \equiv g_1$
- High e shift probability to low g^c state

IMD model fit and comparison with Fund

Target Moments				Non-target Moments			
Variables	Data	IMD	Fund	Variables	Data	IMD	Fund
A. 1^{st} Moments							
b'/y (%)	78.33	78.57	191.00	ps/y (%)	−1.00	1.14	4.70
spread (%)	4.15	4.17	−0.003				
g/y %	21.68	21.74	20.97				
1% of g/y	13.38	15.22	14.44				
99% of g/y	32.80	32.14	32.62				
n (%)	36.37	36.56	37.82				
e	n.a.	0.29	0.34				
B. 2^{nd} Moments							
$\sigma(n)/\sigma(y)$	1.00	0.91	0.70	$\sigma(c)/\sigma(y)$	1.51	1.39	0.36
$\sigma(g)/\sigma(y)$	1.02	1.03	0.70	$\rho(c,y)$	0.63	0.64	0.62
$\sigma(ps/y)/\sigma(y)$	1.00	0.97	0.86	$\rho(n,y)$	0.70	0.10	0.94
$\sigma(\text{spread})$	1.67	1.74	0.00	$\rho(\text{spread},y)$	−0.38	−0.06	−0.48
$\rho(g,y)$	0.38	0.38	0.47	$\rho(ps/y,y)$	0.18	0.23	0.93

The *Fund* contract: 3+2 properties

Consumption smoothing: consumption is less volatile and less procyclical

Countercyclical fiscal policies: primary surpluses are highly procyclical

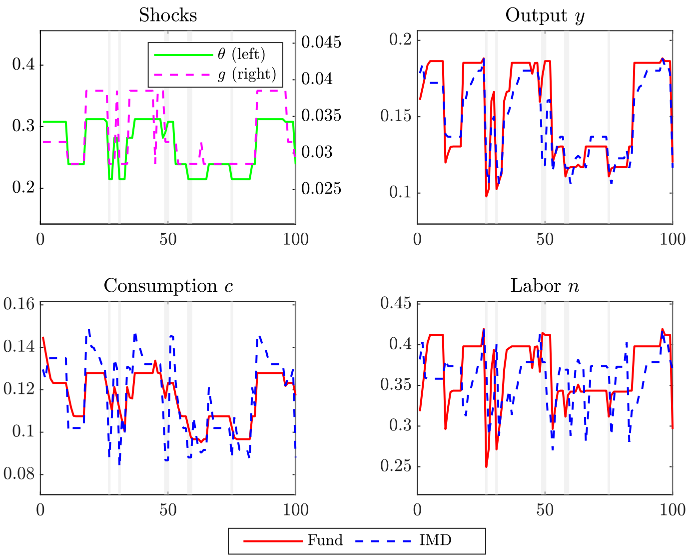
Government bond spreads are very low (& negative): the real spreads of *ESF* contracts (debts) are very low (& negative)

The *Fund* contract: 3+2 properties

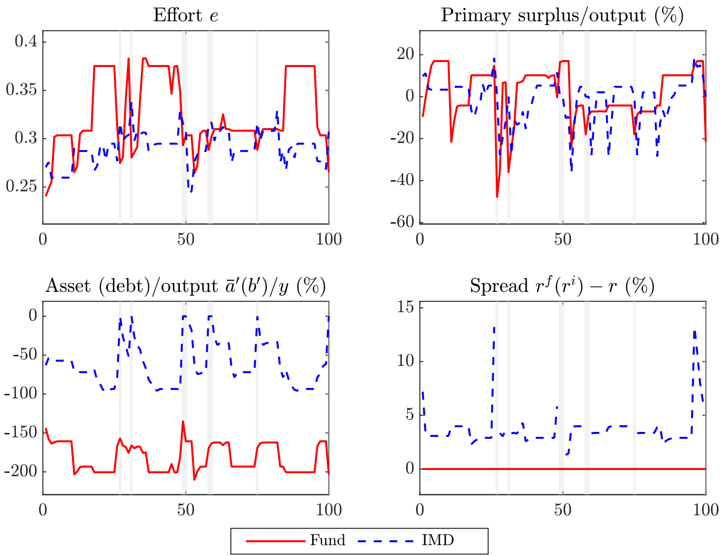
High capacity to absorb severe shocks (& existing debts): in a severe shock (a rare event) a country with an *ESF* contract disposes of a large line of credit

Conditional transfers, not just *ex-ante*: credit in times of crisis is not given with *ex-ante* (austerity plan) conditionality, but conditionality is a *persistent* feature

IMD vs. *Fund* in normal time: allocations



IMD vs. ***Fund*** in normal time: assets



Lessons from contrasting paths

- Repeated defaults ([in grey] to get the spreads right) in incomplete markets
- Positive spreads ‘anticipating’ default when debt is relatively high (even if productivity is also high)
- Default episodes mostly driven by productivity shocks: productivity drops + (relatively) large debt levels
- Larger amount of ‘borrowing’ with the ***Fund***
- Fiscal policies (primary deficit) are more counter-cyclical with the ***Fund***
- Smoother consumption and, correspondingly, more volatile asset holdings and primary deficits with the ***Fund***

Welfare and risk-sharing capacity

Shocks (θ, g^c)	Welfare Gain	$(b'/y)_{\max}$: M	$(b'/y)_{\max}$: F
$(\theta_l, g_h) = (0.148, 0.038)$	5.91	1.71	66.16
$(\theta_m, g_h) = (0.299, 0.038)$	5.59	107.61	165.08
$(\theta_h, g_h) = (0.456, 0.038)$	3.76	215.15	317.09
$(\theta_l, g_l) = (0.148, 0.025)$	5.07	1.84	67.12
$(\theta_m, g_l) = (0.299, 0.025)$	5.14	111.47	164.63
$(\theta_h, g_l) = (0.456, 0.025)$	3.55	214.78	313.82
Average	**5.04**		

- Welfare gains in consumption equivalent terms at $b = 0$ (%).
- $(b'/y)_{\max}$ is the maximum level of country indebtedness expressed as the percentage of GDP in a given financial environment (Markets or Fund). Higher debt would trigger default

Decomposition of welfare gains: % contributions

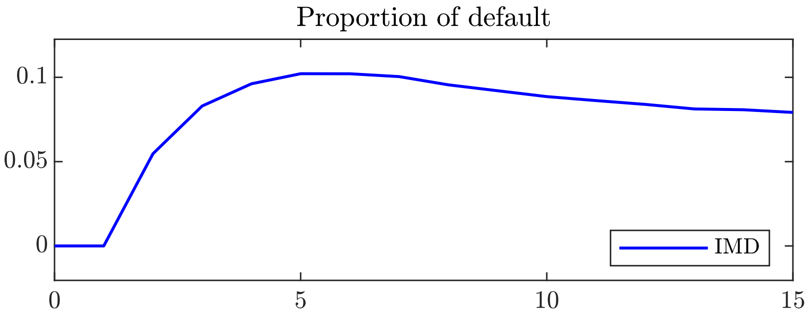
Shocks (θ, g^c)	Productivity penalty	Debt market exclusion	Limited debt capacity	Limited contingency i.e., insurance
(θ_l, g_h)	4.21	0.76	42.58	52.44
(θ_m, g_h)	16.98	4.22	56.77	22.03
(θ_l, g_l)	4.76	1.05	40.60	53.59
(θ_m, g_l)	18.78	4.37	49.56	27.29

Calibrating to the Euro Debt crisis

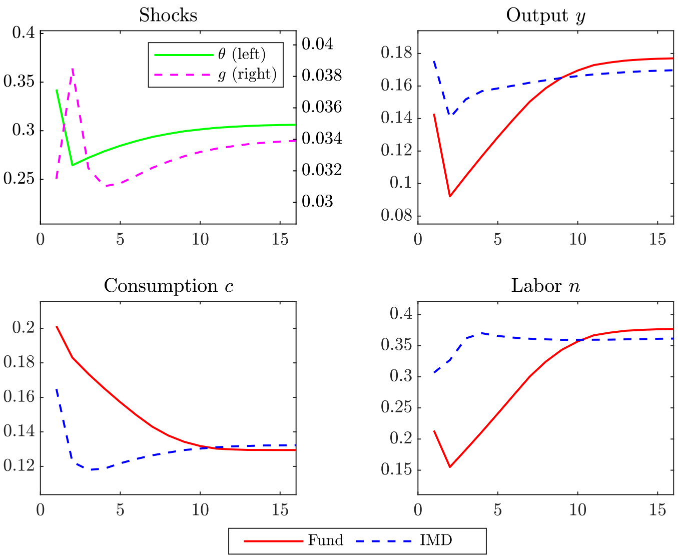
Periods	Avg. b'/y %	Avg. spread %
Before crisis: 2005–2007	78.31	0.78
Crisis eruption: 2009–2010	99.14	4.04

Notes: all moments are the averages over the GIPS countries.

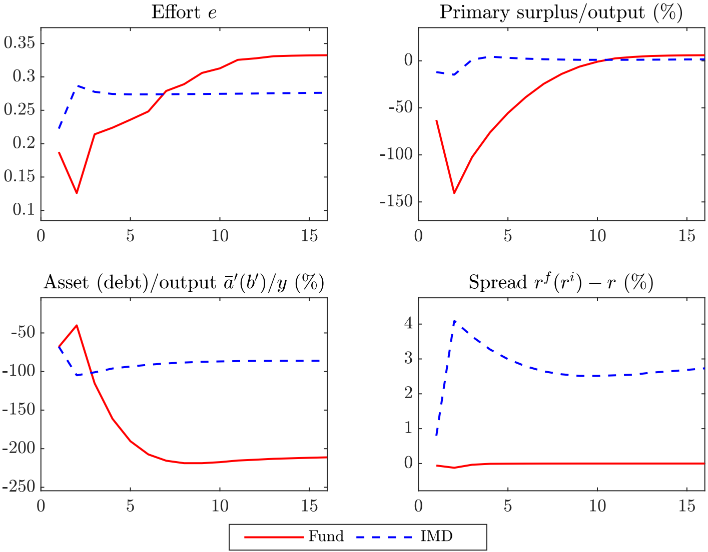
Crisis counterfactual: default frequency



Crisis counterfactual: real variables



Crisis counterfactual: financial variables



Concluding remarks

Even accounting for limited redistribution, the Fund can improve efficiency significantly, with respect to debt financing

I. The Fund can provide the risk sharing that it is provided by taxes & transfers in Federal systems

II. Costly default events may be prevented and severe crises are less likely and/or better handled, by enabling much more countercyclical fiscal policies

III. The Fund is able to absorb significantly more debt than the markets

IV. The Fund provides much better insurance through ex post contingencies

The Fund requires commitment in normal times to avoid time-inconsistency in difficult times. It can also account for moral hazard problems without great distortions

Thank you very much!