Overborrowing, Financial Crises and ‘Macro-prudential’ Policy

Javier Bianchi   Enrique G. Mendoza

University of Wisconsin & NBER   Universtiy of Pennsylvania & NBER

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Financial Crises and Macro-Prudential Policies

- Evidence credit booms typically precede financial crises
- Wide consensus on the need to use Macro-Prudential Policy:

    Prevent "overborrowing" ex ante to make economy less vulnerable to crises ex post

- ....but yet quantitative models helpful for the optimal design of macro-prudential policy are scarce

    Need models that can generate financial crises and evaluate the role for policy

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Key Questions:

1. How does Macro-Prudential Policy affect:
   - The incidence and the severity of financial crises,
   - The behavior of asset prices (excess returns, volatility),
   - Welfare?
2. What are the features of macro-prudential instruments:
   - How should these policies be implemented along the business cycle
   - Their magnitudes
   - Time consistency?

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Contribution

- Answer these questions using an equilibrium model of business cycles and asset prices with a collateral constraint:
  - Binding constraint triggers Fisherian deflation and deep recessions
    → fire sale externality (e.g. Lorenzoni, 2007)
- Characterize constrained efficient allocations under commitment and discretion
- Quantitatively, evaluate outcomes of decentralized equilibrium and time consistent solution
- Examine "simple tax schemes" & "conditional efficient" outcomes

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Main Findings

- Planner can achieve significant reduction in financial fragility:
  - Probability of financial crises decreases by a factor of 3
  - Asset prices fall 17 ppts less (7% v. 24%)
  - Overall cyclical variability is also lower
  - Mean excess return and Sharpe ratio decrease by factors of 6 and 10
- Planner's allocations implementable with **state-contingent taxes on debt** (1% on average and positively corr. with leverage). **Simpler tax schemes** also deliver significant gains

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Related Literature

- **Overborrowing Externalities and Macroprudential Policy**: Caballero and Krishnamurthy (2001), Lorenzoni (2008), Bianchi (2011), Jeanne and Korinek (2011), Benigno et al. (2010), Stein (2012), Kashyap et al. (2012), Gertler, Kiyotaki and Queralto (2012)....

- **Quantitative Models of Macro-Financial Linkages:**
  - **Financial Accelerator Models**: Bernanke-Gertler-Gilchrist (1999); Kiyotaki-Moore (1997); Jermann and Quadrini (2012); Gertler and Kiyotaki (2010)...
  - **Non-Linear (systemic risk) models**: Mendoza (2010), Bianchi (2012), He-Krishnamurthy (2012), Brunnermeier-Sannikov (2011)

Plan of the Talk

1. Analytics of fire-sale externality
2. Quantitative implications
3. Concluding Remarks

Decentralized Competitive Equilibrium

Households solve:

$$\max_{\{c_t, k_{t+1}, b_{t+1}\}_{t\geq 0}} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t u(c_t)$$

$$\begin{aligned} s.t. \quad c_t + q_t k_{t+1} + \frac{b_{t+1}}{R} &= k_t(q_t + z_t) + b_t \\ \frac{b_{t+1}}{R} &\geq -\kappa q_t \end{aligned}$$

z_t follows a Markov process, $\kappa < 1$

- Non-state contingent bonds only
- Capital is unit fixed supply $K = 1$
- Interest rate is exogenous. We look at equilibrium, where households are generally borrowers and constraint binds occasionally

Excess Returns

$$E_t[R^k_{t+1}] - R = \frac{\mu_t(1-\kappa) - Cov_t(\beta u'(c_{t+1}), R^k_{t+1} - R)}{\beta E_t u'(c_{t+1})}$$

Excess Returns

A tightening of the constraint leads to increase in excess returns

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causing asset prices to fall

$$q_t = E_t \sum_{j=0}^{\infty} \frac{z_{t+j+1}}{\prod_{i=0}^{j} E_{t+i} R^k_{t+1+i}}$$

tightening the constraint and feeding back to asset prices

$\Rightarrow$ Ex-ante, leverage magnifies Fisherian deflation $\rightarrow$ systemic risk externality

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Normative Analysis

- Planner chooses borrowing and transfers proceeds of credit market operations
- Land market remains competitive
- Commitment versus Discretion
- Equivalent approach: Ramsey planner choosing debt taxes

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Private Choices in Constrained Efficient Equil.

Taking planner's policies $\{b_{t+1}, T_t\}_{t\geq 0}$ and asset prices as given, households solve:

$$\max_{\{c_t,k_{t+1}\}_{t\geq 0}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

$$s.t. \quad c_t + q_t k_{t+1} \;=\; k_t(q_t + z_t) + T_t$$

First order condition and key implementability condition:

$$q_t u'(c_t) = \beta \mathbb{E}_t \left[u'(c_{t+1}) \left(z_{t+1} + q_{t+1} \right) \right]$$

Commitment Case

Planner solves:

$$\max_{\{c_t, q_t, b_{t+1}\}} \qquad \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

$$\begin{aligned} s.t. \quad c_t + \frac{b_{t+1}}{R_t} &= z_t + b_t \\ \frac{b_{t+1}}{R_t} &\geq -\kappa q_t \\ q_t u'(c_t) &= \beta \mathbb{E}_t u'(c_{t+1})(z_{t+1} + q_{t+1}) \end{aligned}$$

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$$\frac{b_{t+1}}{R_t} \geq -\kappa q_t \quad (\mu_t)$$

$$q_t u'(c_t) = \beta \mathbb{E}_t u'(c_{t+1})(z_{t+1} + q_{t+1}) \quad (\xi_t)$$

Optimality Conditions

$$b_{t+1} :: \quad \lambda_t = \beta R_t E_t \lambda_{t+1} + \mu_t \qquad \forall t \geq 0$$

$$c_t : \quad \lambda_t = u'(c_t) - \xi_t q_t u''(c_t) + u''(c_t)\xi_{t-1}(q_t + z_t) \qquad \forall t > 0$$

$$q_t :: \quad \xi_t = \xi_{t-1} + \frac{\mu_t \kappa}{u'(c_t)} \qquad \forall t > 0$$

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Current consumption raises current asset prices

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But current consumption also lowers previous asset prices

→ Solution is time inconsistent

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Euler Equation for Bonds

Decentralized Equilibrium ($\mu_t = 0$)

$$u'(c_t) = \beta R \mathbb{E}_t u'(c_{t+1})$$

1. $\xi_{t-1} = 0, \mu_t = 0$

$$u'(c_t) = \beta R \mathbb{E}_t \left(u'(c_{t+1}) - \frac{\mu_{t+1}\kappa}{u'(c_{t+1})} q_{t+1} u''(c_{t+1}) \right)$$

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Positive wedge between social and private marginal benefits from borrowing.

→ Fire sale externality: Borrow less today to avoid sharp drop in asset price tomorrow

2. $\xi_{t-1} > 0, \mu_t = 0$

$$u'(c_t) + \xi_{t-1}(z_t u''(c_t) - \mathbb{E}_t u''(c_{t+1}) z_{t+1}) \quad = \\ \beta R \mathbb{E}_t \left(u'(c_{t+1}) - \frac{\mu_{t+1}\kappa}{u'(c_{t+1})} q_{t+1} u''(c_{t+1}) \right)$$

Theoretically ambiguous **current wedge** between private and social benefit from borrowing due to effects on **previous constraints**.

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Theoretically ambiguous **current wedge** between private and social benefit from borrowing due to effects on **previous constraints**. Normally, a positive wedge if constraints are expected to bind.

Decentralized Equilibrium ($\mu_t > 0$)

$$u'(c_t) = \beta R \mathbb{E}_t u'(c_{t+1}) + \mu_t$$

3. $\xi_{t-1} = 0, \mu_t > 0$

$$u'(c_t) - \frac{\mu_t \kappa q_t u''(c_t)}{u'(c_t)} =$$

$$\beta R \mathbb{E}_t \left(u'(c_{t+1}) - \frac{\mu_{t+1}\kappa}{u'(c_{t+1})} q_{t+1} u''(c_{t+1}) + u''(c_{t+1}) \mu_t z_{t+1} \right) + \mu_t$$

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→ Time consistency problem: Promise lower consumption tomorrow to relax constraint today

Time Consistent Planner's Problem

Taking as given future policies $\mathcal{C}$, planner solves:

$$V(b,z) = \max_{c,b',q} u(c) + \beta \mathbb{E} V(b',z')$$

subject to

$$\begin{aligned} c + \frac{b'}{R} &= b + z_t && (\lambda) \\ \frac{b'}{R} &\geq -\kappa q && (\mu) \end{aligned}$$

$$q = \frac{\beta E u'(\mathcal{C}(b',z')(\mathcal{Q}(b',z') + z')}{u'(c)} \qquad (\xi)$$

▸ Foc

Euler Equation Comparison

Under discretion:

$$u'(c) - \xi_t u''(c_t) q_t = \beta R \mathbb{E}_t \left(u'(c_{t+1}) - \xi_{t+1} u''(c_{t+1}) \mathcal{Q}_{t+1} \right) +$$

$$\beta \mathbb{E}_t \left(u''(c_{t+1}) \mathcal{C}_b(t+1) (\mathcal{Q}_{t+1}(t+1)) + z_{t+1} \right) + \mathcal{Q}_b(t+1) u'(c_{t+1}) \big) + \mu_t$$

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Remarks on Scope for Policy

Two sources of welfare improving policies:

1. Make **future** constraints less binding

   Borrow less today to reduce fire sales in the future

2. Make **current** constraints less binding:

   (a) Lower future consumption raises current asset prices

   → Requires commitment

   (b) Higher consumption raises current asset prices

   → Non-feasible

Remark: Conditional Efficiency ≈ Time Consistent Solution

CE solution

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Quantitative Model

- Introduce firms, labor supply and working capital
- Capital has individual value as collateral
- Model calibrated to industrialized countries
    - Target of long-run moments include a 3 percent crisis probability
- Focus on time consistent solution

Representative Firm-Household Problem

Maximize:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_t - G(n_t^s)) \right]$$

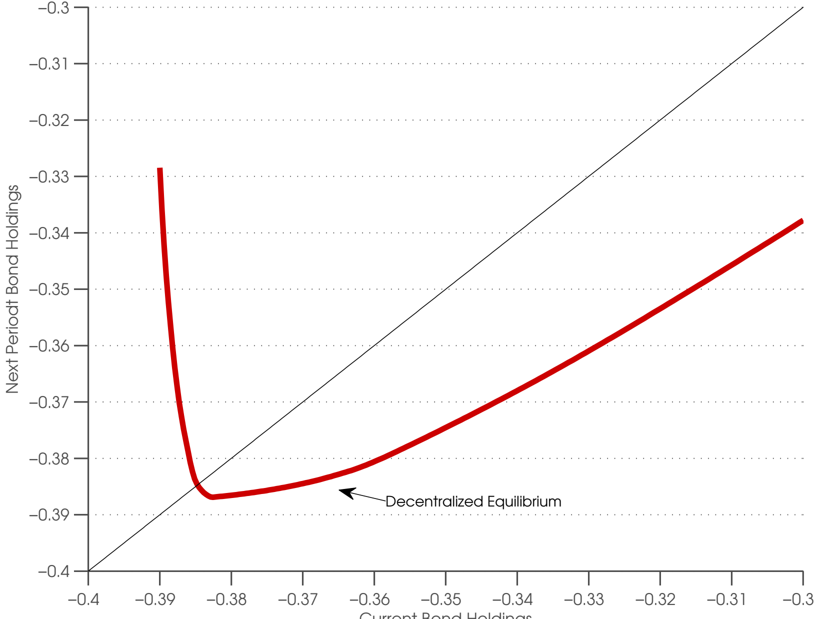
subject to budget constraint

$$q_t k_{t+1} + c_t + \frac{b_{t+1}}{R} = q_t k_t + b_t + w_t n_t^s + [\varepsilon_t F(k_t, n_t^d) - w_t n_t^d]$$

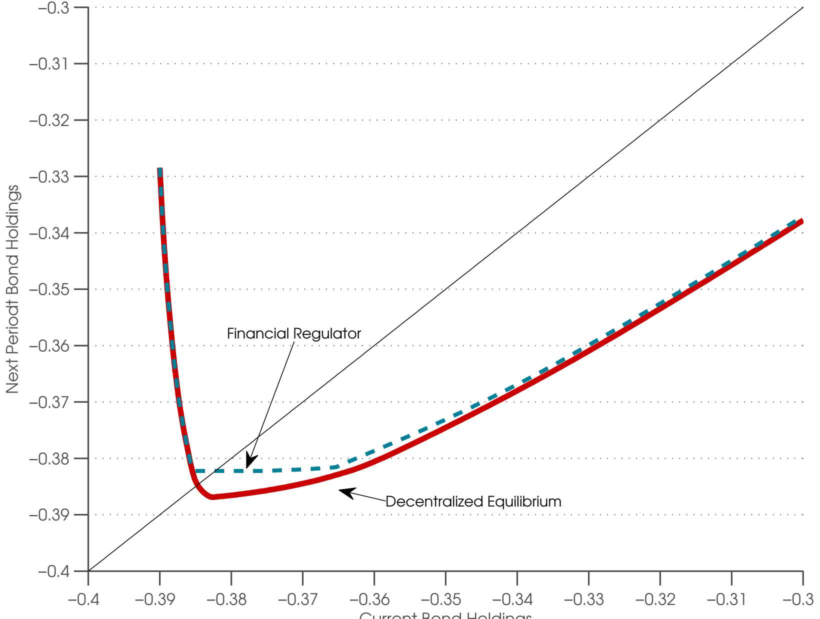
and collateral constraint

$$-\frac{b_{t+1}}{R} + \theta w_t n_t^d \leq \kappa q_t k_{t+1}$$

Law of Motion for Bonds



Law of Motion for Bonds



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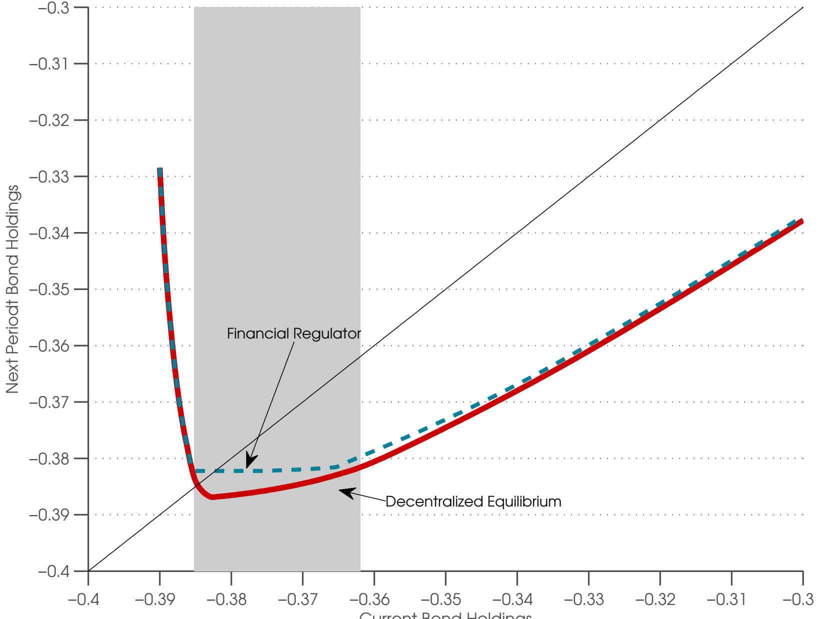
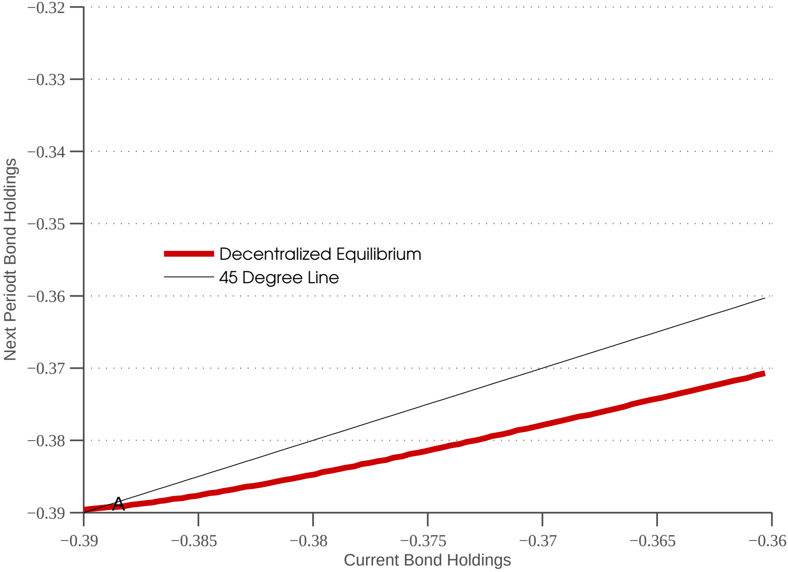
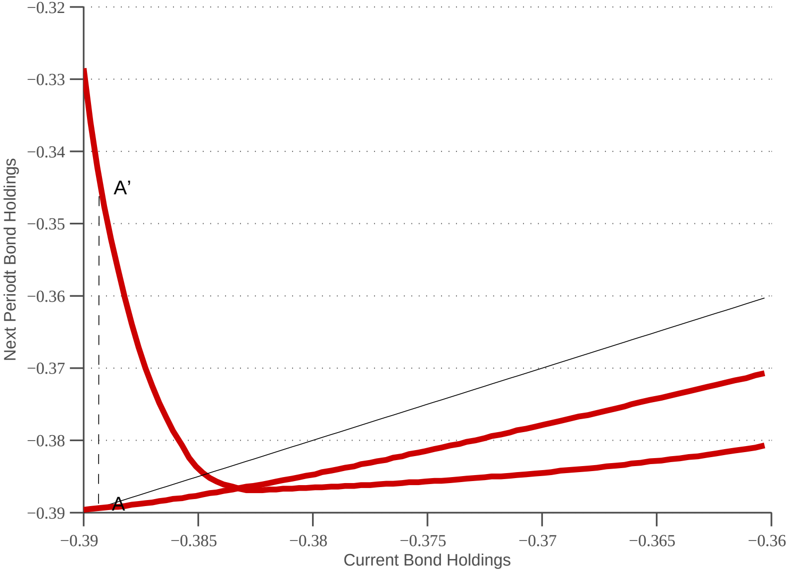


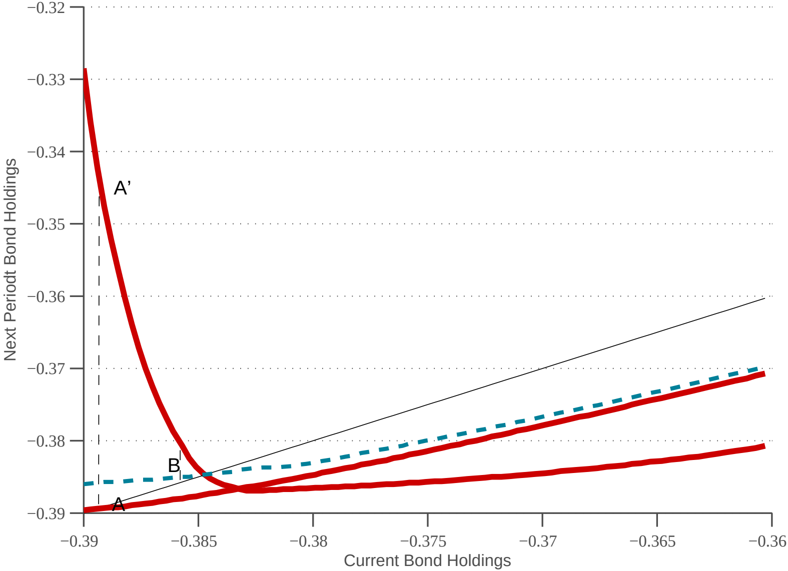
Debt Dynamics: Decentralized Equilibrium



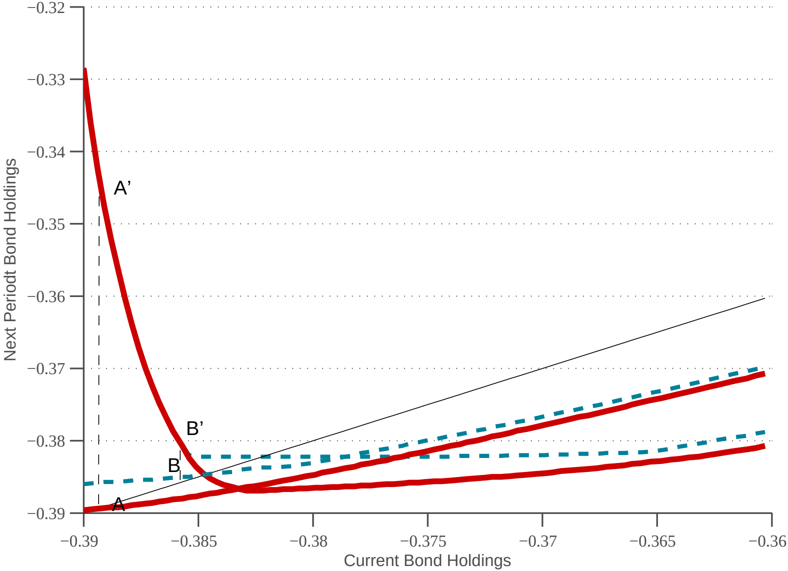
Debt Dynamics when Bad Shock hits



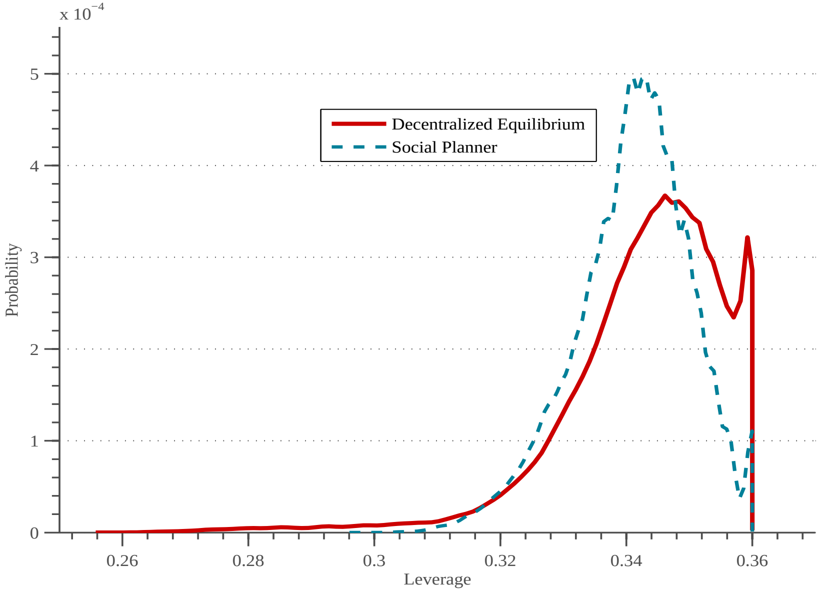
Small diff. in debt in normal times...



Leads to large differences in crises

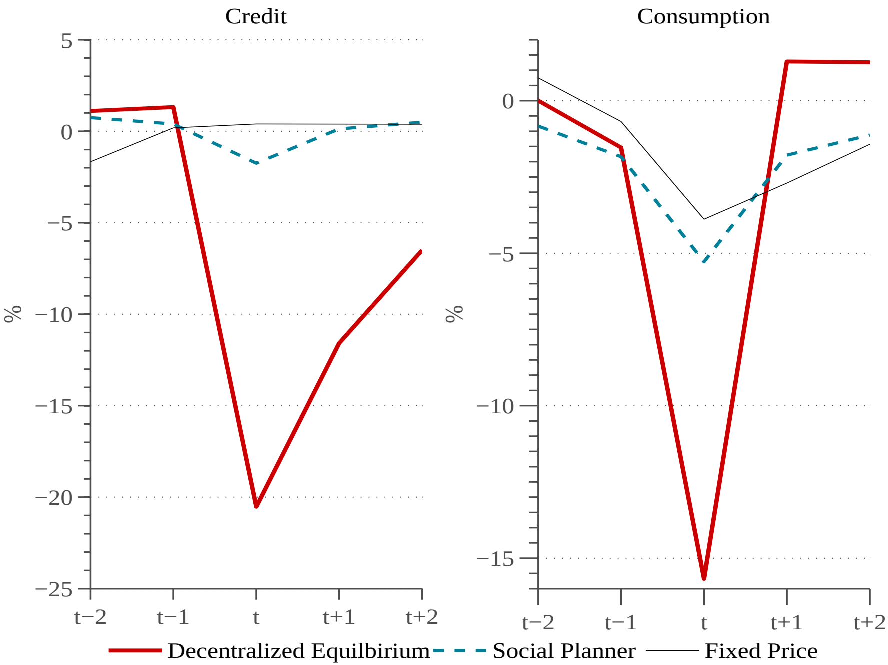


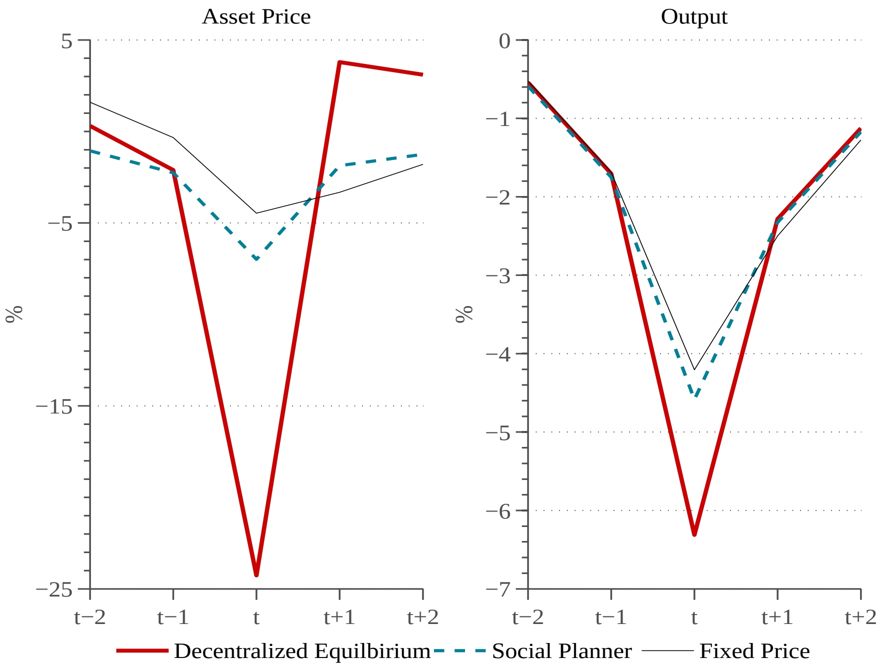
Distribution of Leverage (measured as $\frac{b_{t+1}+\theta w_t h_t}{q_t k_t}$)

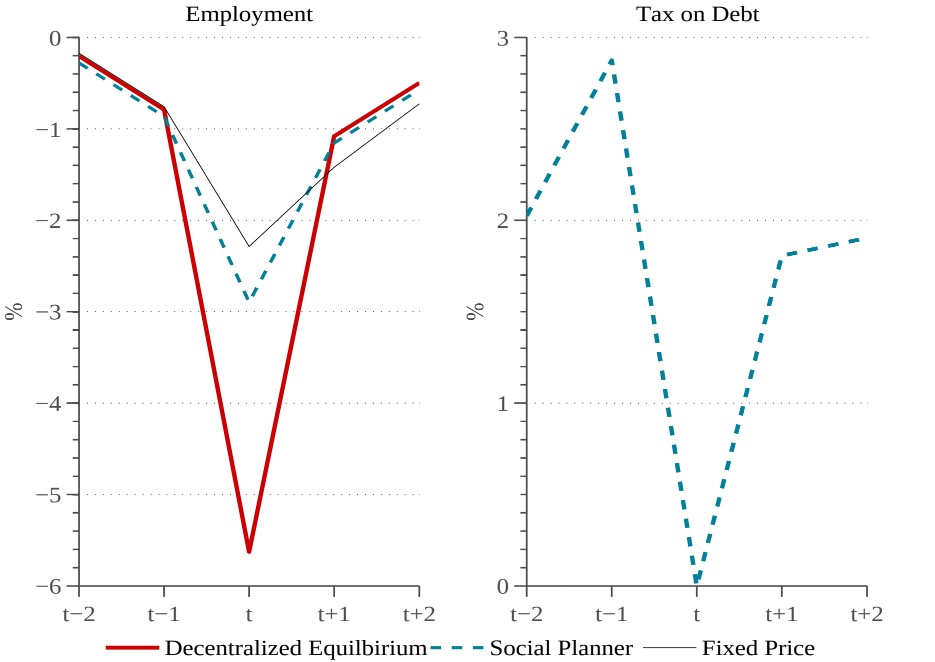


Comparison of Financial Crises: Event Analysis

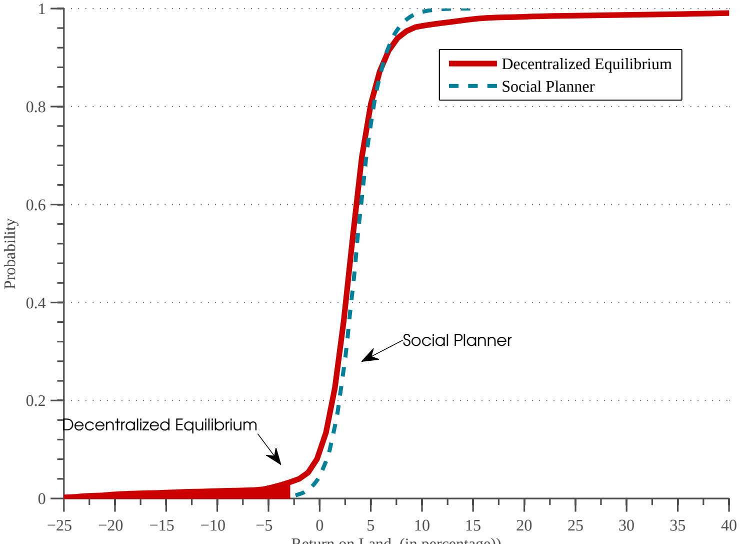
- Use decision rules to simulate DE and SP for 100,000 periods
- Define a crisis event: binding credit constraint and a fall in credit of credit of more than 1 SD
- Isolate five-year event windows centered in financial crisis periods'
- Compute median shocks in $t-2, t-1, t, t+1, t+2$ and median initial debt level at $t-2$
- Simulate 'DE' and 'SP' given initial debt level and sequence of shocks

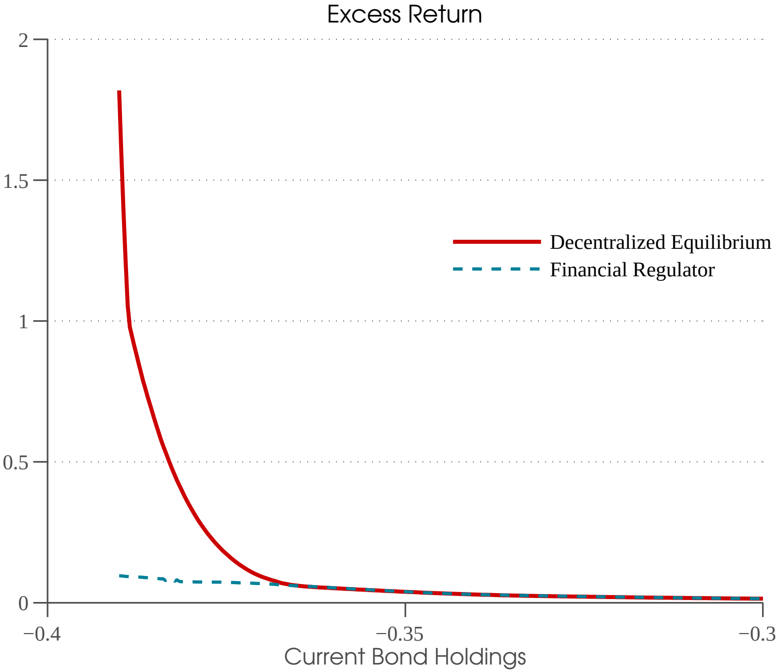

Credit
Consumption
5
0
−5
−10
−15
−20
−25
%
t−2
t−1
t
t+1
t+2
Decentralized Equilbirium
Social Planner
Fixed Price

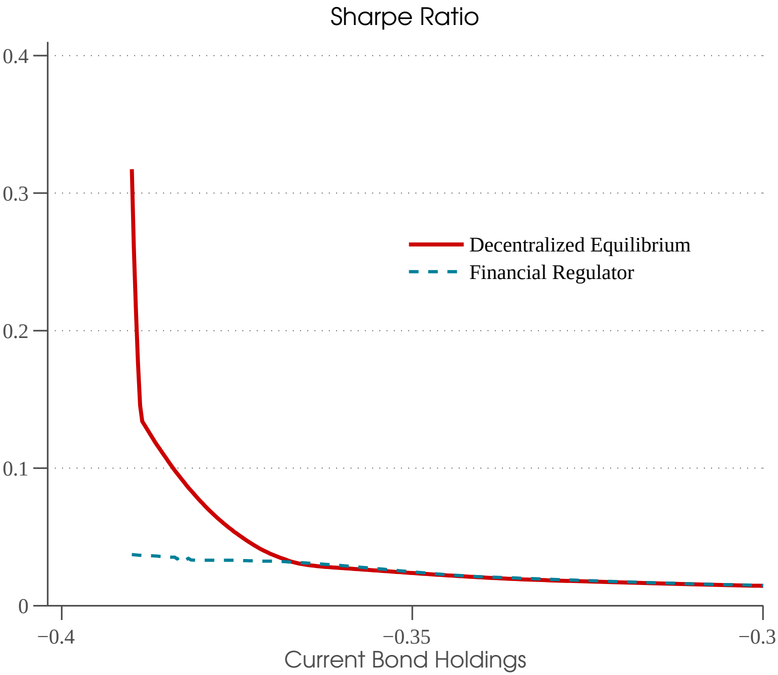

Asset Price
Output
5
−5
−15
−25
0
−1
−2
−3
−4
−5
−6
−7
%
%
t−2
t−1
t
t+1
t+2
Decentralized Equilbirium
Social Planner
Fixed Price


Employment
Tax on Debt
%
0
−1
−2
−3
−4
−5
−6
3
2
1
0
t−2
t−1
t
t+1
t+2
Decentralized Equilbirium
Social Planner
Fixed Price

"Fat Tail in Land Returns" (ergodic CDFs of returns)




Excess Return
2
1.5
1
0.5
0
−0.4
−0.35
−0.3
Current Bond Holdings
Decentralized Equilibrium
Financial Regulator



Sharpe Ratio
0.4
0.3
0.2
0.1
0
Decentralized Equilibrium
Financial Regulator
−0.4
−0.35
−0.3
Current Bond Holdings

Welfare Analysis

Welfare effects calculated as increase in permanent consumption that renders DE and SP in terms of utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{DE}(1+\gamma) - G(n_t^{DE})) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{SP} - G(n_t^{SP}))$$

- Two sources of welfare effects from the externality:
  - Production efficiency is affected when constraint binds
  - Larger drops in consumption when constraint binds
- 0.05 percentage points on average
- Higher in the run-up to a financial crisis (about 1.5 times higher)

Conclusions

- Fire-sale externalities increase magnitude and incidence of financial crises, mean excess returns, volatility of returns and Sharpe ratios
- State contingent taxes on debt can implement the constrained efficient allocations. Simple policies are also effective.
- MPP has to adapt to fin. innovation and differences in information/beliefs (Bianchi, Boz & Mendoza (2012))
- Road ahead: value of commitment

Optimality Conditions

$$b_{t+1} :: \quad \lambda_t = \beta R_t E_t \lambda_{t+1} + \mu_t \qquad \forall t \geq 0$$

$$c_t : \quad \lambda_t = u'(c_t) - \xi_t q_t u''(c_t) + u''(c_t)\xi_{t-1}(q_t + z_t) \qquad \forall t > 0$$

$$q_t :: \quad \xi_t = \xi_{t-1} + \frac{\mu_t \kappa}{u'(c_t)} \qquad \forall t > 0$$

commitment

Optimality Conditions

$$b_{t+1} :: \quad \lambda_t = \beta R_t E_t \lambda_{t+1} + \mu_t \qquad \forall t \geq 0$$

$$c_t : \quad \lambda_t = u'(c_t) - \xi_t q_t u''(c_t) + u''(c_t)\xi_{t-1}(q_t + z_t) \qquad \forall t > 0$$

$$q_t :: \quad \xi_t = \xi_{t-1} + \frac{\mu_t \kappa}{u'(c_t)} \qquad \forall t > 0$$

ξ_t is a positive non-decreasing sequence

Optimality Conditions

$$b_{t+1}: \quad \lambda_t = \beta R \mathbb{E}_t \lambda_{t+1} +$$

$$\beta \mathbb{E}_t \left(u''(c_{t+1}) \mathcal{C}_b(t+1)(\mathcal{Q}_{t+1}(t+1)) + z_{t+1}) + \mathcal{Q}_b(t+1) u'(c_{t+1}) \right) + \mu_t$$

$$c_t: \quad \lambda_t = u'(c_t) - \xi_t u''(c_t) q_t$$

$$q_t: \quad \kappa \mu_t = \xi_t u'(c)$$

discretion

Calibration

		Source / target
Interest rate	$R - 1 = 0.028$	U.S. data
Risk aversion	$\sigma = 2$	Standard DSGE value
Share of labor	$\alpha_n = 0.64$	U.S. data
Labor disutility coefficient	$\chi = 0.64$	Normalization
Frisch elasticity parameter	$\omega = 1$	Kimball and Shapiro (2008)
Supply of land	$\bar{K} = 1$	Normalization
Working capital coefficient	$\theta = 0.14$	Working Capital-GDP=9%
Discount factor	$\beta = 0.96$	Debt-GDP ratio= 38%
Collateral coefficient	$\kappa = 0.36$	Frequency of Crisis = 3%
Share of land	$\alpha_K = 0.05$	Housing-GDP ratio = 1.35
TFP process	$\sigma_\varepsilon = 0.014, \rho_\varepsilon = 0.53$	Std. dev. and autoc. of U.S. GDP

Conditional Efficiency

$$V(B,z) = \max_{B',c} \left[u(c) + \beta E_{z'|z} V(B',z') \right]$$

$$c + \frac{B'}{R} = z + B$$

$$-\frac{B'}{R} \leq \kappa q(B,z)$$

Taking as given $q(B,z) = q^{DE}(B,z)$, back