Are Collateral-Constraint Models Ready for Macroprudential Policy Design?

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Motivation

- **Paradigm change** in last decade related to capital-control policies
  - Central policy institutions (IMF, WB) open to **use of macroprudential policies**
  - Currently capital controls part of standard policy toolkit Fernandez et al 2016
  - Sharp contrast to consensus prior to global financial crisis
- Large **advances in academic research** on financial-friction-driven inefficient borrowing
  - 1st building block: **theory** Geanakoplos Polemarchakis 86, Kehoe Levine 01, Lorenzoni 08
  - 2nd building block: **quantitative** Bianchi 11, Benigno et al 13, Bianchi Mendoza 18

What We Do

We study:

- Dynamic incomplete-markets SOE model with **general collateral constraints**

We find:

- Desirability of macroprudential policies depends on specific form of collateral
- **Efficiency** when **future prices** affect collateral, inefficiencies with current prices
- Distinguishing between these model specifications is challenging:
  - Plausible theoretical microfoundations for both
  - Quantitative versions of both specifications can account for main data features

Takeaway:

- Value of direct empirical evidence on policy transmission & microstructure of contracts

Outline of the Talk

1. Model environment
2. Main theorem
3. Distinguishing models
    - Microfoundations
    - Quantitative analysis
4. Extension: model with capital-based collateral

Model Overview

- Canonical, incomplete-markets SOE model
- Endowment economy with tradable and non-tradable goods
  - Endowments subject to aggregate risk
- Incomplete markets
  - One-period, risk-free debt
- Financial frictions
  - Collateral constraint linked to the value of income
  - Extend analysis to collateral linked to value of capital (later)

Households

- Preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t\right), \quad c_t = C(c_t^T, c_t^N)$$

- Endowments

$$y_t^{\mathrm{T}} \in \mathcal{Y}_{\mathrm{T}},\ y_t^{\mathrm{N}} \in \mathcal{Y}_{\mathrm{N}}$$

- Budget constraint

$$c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}} + R d_t = y_t^{\mathrm{T}} + p_t y_t^{\mathrm{N}} + d_{t+1}$$

- Two prices in the economy:
  - Relative price of NT goods p_t (endogenous)
  - Debt price R (priced by deep-pocket foreign investors)

Collateral Constraint

General Formulation:

$$d_{t+1} \leq \mathcal{D}(\{p_{t+h}\}_{h=0}^{\infty})$$

Two Particular Cases:

1. Current income as collateral

$$\mathcal{D}(\{p_{t+h}\}_{h=0}^{\infty}) = \kappa_t \left(y_t^{\mathrm{T}} + p_t y_t^{\mathrm{N}}\right)$$

2. Next-period income as collateral

$$\mathcal{D}(\{p_{t+h}\}_{h=0}^{\infty}) = \min_{\substack{\{y_{t+1}^{\mathrm{T}}, y_{t+1}^{\mathrm{N}}, \\ p_{t+1}\}}} \kappa_t \left(y_{t+1}^{\mathrm{T}} + p_{t+1} y_{t+1}^{\mathrm{N}}\right)$$

Equilibrium

1. Intra-temporal optimality

$$\frac{C_N(c_t^{\mathrm{T}}, c_t^{\mathrm{N}})}{C_T(c_t^{\mathrm{T}}, c_t^{\mathrm{N}})} \equiv \mathcal{P}\left(c_t^{\mathrm{T}}, c_t^{\mathrm{N}}\right) = p_t$$

2. Euler equation

$$u_{\mathrm{T}}(c_t^{\mathrm{T}}, c_t^{\mathrm{N}}) = \beta R \mathbb{E}_t u_T(c_{t+1}^{\mathrm{T}}, c_{t+1}^{\mathrm{N}}) + \mu_t$$

3. Complementary slackness

$$\mu_t \left(\mathcal{D}(\{p_{t+h}\}_{h=0}^{\infty}) - d_{t+1}\right) = 0$$

4. Market clearing

$$c_t^{\mathrm{N}} = y_t^{\mathrm{N}}$$

$$c_t^{\mathrm{T}} = y_t^{\mathrm{T}} + d_{t+1} - Rd_t$$

Social Planner Problem

- Benevolent government can tax households' borrowing, lacks commitment

$$\max_{c_t^T, d_{t+1}} \mathbb{E}_t \sum_{h=0}^{\infty} \beta^h u(C(c_{t+h}^T, y_{t+h}^N))$$

s.t.

$$\begin{aligned}
&\text{Resource constraint:} && c_{t+h}^T = y_{t+h}^T + d_{t+h+1} - R d_{t+h}, \\
&\text{Borrowing constraint:} && d_{t+1} \leq \mathcal{D}(\{\mathcal{P}(c_{t+h}^T, y_{t+h}^N)\}_{h=0}^H), \\
&\text{Equilibrium price:} && \mathcal{P}(c_{t+h}^T, y_{t+h}^N) = \frac{C_N(c_{t+h}^{\mathrm{T}}, c_{t+h}^{\mathrm{N}})}{C_T(c_{t+h}^{\mathrm{T}}, c_{t+h}^{\mathrm{N}})}
\end{aligned}$$

taking as given future policies, $\mathcal{C}_{t+h}^T(d_{t+h})\ \forall h \geq 1$

- Euler equation not a constraint with capital control taxes available

Efficiency with future income as collateral

Theorem:

Under certain regularity conditions (differentiable policies, consumption decreasing in debt):

If borrowing limit is independent of current relative price of NT goods $\left(\frac{\partial \mathcal{D}}{\partial p_t} = 0\right) \Rightarrow$

the **equilibrium is constrained efficient**.

Sketch of Proof

- Focus on particular case of next-period income used as collateral
- Equilibrium first-order conditions

$$u_T(t) = \beta R \mathbb{E}_t u_T(t+1) + \mu_t$$

- Social planner's first-order conditions

$$u_T(t) = \beta R \mathbb{E}_t u_T(t+1) + \mu_t^{sp}[1 - \mathcal{D}_1 \mathcal{P}_T(t+1) \mathcal{C}_d^T(t+1)]$$

Sketch of Proof

- Focus on particular case of next-period income used as collateral
- Equilibrium first-order conditions

$$u_T(t) = \beta R \mathbb{E}_t u_T(t+1) + \mu_t$$

one-to-one mapping

- Social planner's first-order conditions

$$u_T(t) = \beta R \mathbb{E}_t u_T(t+1) + \mu_t^{sp}[1 - \mathcal{D}_1 \mathcal{P}_T(t+1) \mathcal{C}_d^T(t+1)]$$

$[1 - \mathcal{D}_1 \mathcal{P}_T(t+1) \mathcal{C}_d^T(t+1)] > 0$ guarantees all eq. conditions are satisfied

Inefficiency with Current Income as Collateral

- Focus on particular case of current income used as collateral
- Equilibrium first-order conditions

$$u_T(t) = \beta R \mathbb{E}_t u_T(t+1) + \mu_t$$

no one-to-one mapping

- Social planner's first-order conditions

$$u_T(t) = \beta R \mathbb{E}_t u_T(t+1) + \beta R \mathbb{E}_t \Psi_{t+1} \mu_{t+1}^{sp} + \mu_t^{sp}$$

- If $\mu_t = 0$ and $E_t \mu_{t+1} > 0$, there is room for policy

Microfoundations

- Future income as collateral
- Value of repaying:

$$V^R(\mathbf{y}, d) = \max_{c_t^T, c_t^N, d_{t+1}} u\left(C\left(c_t^T, c_t^N\right)\right) + \beta \mathbb{E}_t \left[\max\{V^R(\mathbf{y}_{t+1}, d_{t+1}), V^D(\mathbf{y}_{t+1})\}\right]$$

$$\text{st} \quad c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}} + d_t = y_t^{\mathrm{T}} + p_t y_t^{\mathrm{N}} + q_t(d_{t+1}) d_{t+1}$$

- Value of defaulting:

$$V^D(\mathbf{y}, d) = \max_{c_t^T, c_t^N, d_{t+1}} u\left(C\left(c_t^T, c_t^N\right)\right) + \beta \mathbb{E}_t \left[\max\{V^R(\mathbf{y}_{t+1}, d_{t+1}), V^D(\mathbf{y}_{t+1})\}\right]$$

$$\text{st} \quad c_t^{\mathrm{T}} + p_t c_t^{\mathrm{N}} = (1 - \kappa_t)(y_t^{\mathrm{T}} + p_t y_t^{\mathrm{N}}) + q_t(d_{t+1}) d_{t+1}$$

- Sufficiently high default costs for lender $\Rightarrow$ kinked $q_t(d_{t+1})$ & no on-equilibrium default

Microfoundations

- Future income as collateral
  - Borrowers lack commitment and can default in the repayment period
  - If borrowers default, lenders can seize a fraction κ of income
  - Off-equilibrium default (sufficiently high cost of default for lenders)
- Current income as collateral
  - Default by borrowers requires fraud in the borrowing period
  - Fraud is perfectly observed by lenders
  - If lenders observe fraud they can seize a fraction κ of current income

Quantitative Analysis

- Calibrate model to Argentina, annual frequency
- Functional forms:
  - CRRA utility function, CES aggregator between T and NT goods (ω: weight on T)
  - Endowment processes estimated from data
- Two calibrations for current- and future-income collateral
- Subset of parameters common across calibrations
  - risk aversion, intra-temporal elasticity, interest rate
  - endowment process

Calibration

1. Current-income collateral calibration
   - Set $\{\beta, \kappa, \omega\}$ to match three key moments
     - Average NFA position: 30% of GDP
     - Frequency of sudden stops: 5.8%
     - Share of tradables in GDP: 32%
2. Future-income collateral calibration
   - Similar strategy but add shocks to κ
     - necessary to generate sudden stops Benigno Fornaro (12) Guerrieri Lorenzoni (17)
   - Assume $\kappa(s) \in \{\kappa, \bar{\kappa}\}$ follows a Markov process
     - set $\bar{\kappa}$ large enough that the constraint never binds
     - set $\{\beta, \kappa, \omega\}$ to match same moments as before

Business Cycle Statistics

	Data	Current Income	Future Income
Standard deviations			
Consumption	6.2	5.61	4.62
Real Exchange Rate	8.2	8.05	6.20
Current Account–GDP	3.6	2.41	1.32
Trade Balance–GDP	2.4	2.54	1.39
Correlations with GDP			
Consumption	0.88	0.94	0.88
Real Exchange Rate	0.41	0.95	0.91
Current Account–GDP	−0.63	−0.54	−0.17
Trade Balance–GDP	−0.84	−0.55	−0.28

Capital-based Collateral Model

- Similar framework with capital-based collateral constraints
- Supply side:
  - Firms produce single tradable good with capital & labor
  - Capital in fixed supply
- Segmented markets: capital priced by households & debt priced by foreign investors
- Households can borrow against the value of physical capital
- Two cases of borrowing constraints:
  1. Capital valued at current prices Bianchi Mendoza (18) $d_{t+1} \leq \kappa q_t k_{t+1}$
  2. Capital valued at future prices Kiyotaki Moore (97) $d_{t+1} \leq \kappa \min q_{t+1} k_{t+1}$

Capital-based Collateral: Efficiency with Future Prices

- Consider future price collateral constraint $d_{t+1} \leq \kappa \min q_{t+1} k_{t+1}$
- Euler equation for capital, prices capital

$$q_t = E_t\left[\beta(\alpha z_{t+1} + q_{t+1})\frac{u'(c_{t+1})}{u'(c_t)}\right] + \mu_t \kappa \min\left\{q_{t+1}\right\}$$

- CE Euler equation for debt

$$\frac{1}{R_t} = E_t\left[\beta\frac{u'(c_{t+1})}{u'(c_t)}\right] + \mu_t$$

- Social planner's Euler equation for debt

$$\frac{1}{R_t} = E_t\left[\beta\frac{u'(c_{t+1})}{u'(c_t)}\right] + \mu_t^{sp}\left(1 - \kappa \mathcal{C}_d^T(t+1)\frac{\partial \mathcal{Q}_{t+1}}{\partial c_{t+1}^T}\right)$$

Capital-based Collateral: Efficiency with Future Prices

- Consider future price collateral constraint $d_{t+1} \leq \kappa \min q_{t+1} k_{t+1}$
- Euler equation for capital, prices capital

$$q_t = E_t\left[\beta(\alpha z_{t+1} + q_{t+1})\frac{u'(c_{t+1})}{u'(c_t)}\right] + \mu_t \kappa \min\left\{q_{t+1}\right\}$$

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$$\frac{1}{R_t} = E_t\left[\beta\frac{u'(c_{t+1})}{u'(c_t)}\right] + \mu_t$$

one-to-one mapping

- Social planner's Euler equation for debt

$$\frac{1}{R_t} = E_t\left[\beta\frac{u'(c_{t+1})}{u'(c_t)}\right] + \mu_t^{sp}\left(1 - \kappa \mathcal{C}_d^T(t+1)\frac{\partial \mathcal{Q}_{t+1}}{\partial c_{t+1}^T}\right)$$

- Same mapping possible, provided that asset price $\mathcal{Q}_t$ increases with consumption

Conclusions

- Policy prescriptions of quantitative models depend on specific form of collateral
  - Collateral constraint linked to current rather prescribe intervention, future prices not
- In both cases, macropru policies curb borrowing & reduce occurrence of financial crises
- Future empirical research can help guide these models
  - Characterization of borrowing contracts & how policy affects collateral