Coordination and Crisis in Monetary Unions

Aguiar, Amador, Farhi, and Gopinath (WP, 2015)

Sargent Reading Group
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April 7, 2015

Monetary Unions

- Large literature on shock stabilization
- Euro crisis uncovered other types of tensions
- Policy games

This paper

- Inflation, nominal debt dynamics and self-fulfilling debt crises
- (lack of) Policy coordination and commitment
- Debt ceilings, optimal currency areas

Roadmap

1. Set-up, deterministic model
2. Fiscal externalities
3. Rollover crises
4. Optimal composition of a currency union

Environment

- Time is continuous and infinite, $t \in [0, \infty)$
- Continuum of SOE's form a monetary union
- Single consumption good, domestic price

$$P(t) = P(0) \exp\left[\int_0^t \pi(t) \mathrm{d}t\right]$$

- Each economy endowed with y units of good each period
- Preferences
  1. Continuum of small open economies, $i \in [0, 1]$

$$U^f = \int_0^\infty e^{-\rho t}[u(c_i(t)) - \psi(\pi(t))]\mathrm{d}t$$

  2. Monetary authority

$$U^m = \int_0^\infty e^{-\rho t} \left(\int [u(c_i(t)) - \psi(\pi(t))]\mathrm{d}i \right) \mathrm{d}t$$

  3. Continuum of risk-neutral lenders with outside option ρ

Bond Markets and Default

- Each SOE issues a non-contingent nominal bond that is continuously rolled over

$$\dot{b}_i(t) = c_i(t) - y + [r_i(t) - \pi(t)]b_i(t)$$

- Fiscal authority lacks commitment to repay debt

- Value of default at T

$$\underline{V}(T) = \frac{u[(1-\chi)y]}{\rho} - \int_T^\infty e^{-\rho(t-T)}\psi(\pi(t))\mathrm{d}t$$

Symmetric MPE

- Focus on union with high debt and low debt members

$$\mathbf{b}_H(t) \equiv \frac{1}{\eta} \int_{i \in H} b_i(t) \mathrm{d}i$$
$$\mathbf{b}_L(t) \equiv \frac{1}{1-\eta} \int_{i \in L} b_i(t) \mathrm{d}i$$

$\mathbf{b}(t) = (\mathbf{b}_H(t), \mathbf{b}_L(t))$ is the aggregate state.

- Perfect foresight equilibrium with no rollover crises.

Problems

Fiscal authority

$$V(b,\mathbf{b}) = \max_{c(t)} \int_0^\infty e^{-\rho t}[u(c(t)) - \psi_0 \Pi(\mathbf{b}(t))]\mathrm{d}t$$

subject to

$$\dot{b}(t) = c(t) - y + [r(b(t),\mathbf{b}(t)) - \Pi(\mathbf{b}(t))]b(t)$$

$$\dot{\mathbf{b}}_j(t) = \tilde{C}(\mathbf{b}_j(t),\mathbf{b}(t)) - y + [r(\mathbf{b}_j(t),\mathbf{b}(t)) - \Pi(\mathbf{b}(t))]\mathbf{b}_j(t), j = H, L$$

$$b(t) \in \bar{\Omega}, t \geq 0$$

Monetary authority

$$J(\mathbf{b}) = \max_{\pi(t)\in[0,\bar{\pi}]} \int_0^\infty [\eta u(C(\mathbf{b}_H(t)) + (1-\eta)u(C(\mathbf{b}_L(t))) - \psi_0 \pi(t)]\mathrm{d}t$$

subject to

$$\dot{\mathbf{b}}_j(t) = C(\mathbf{b}_j(t)) + [r(\mathbf{b}_j(t),\mathbf{b}(t)) - \pi(t)]\mathbf{b}_j(t) - y$$

Recursive Competitive Equilibrium

Interest rate schedule r, value functions V, J, policy functions C, Π such that

1. V solves the fiscal authority's problem and C is the associated policy function
2. J solves the monetary authority's problem and Π is the associated policy function
3. Bond holders break even
$$r(b, \mathbf{b}) = \rho + \Pi(\mathbf{b})$$
4. $V(b, \mathbf{b}) \geq \underline{V}(\mathbf{b})$

Monotone Equilibrium

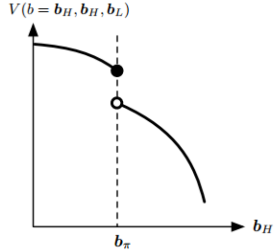
Define $\mathbf{b}_\pi(\mathbf{b}_L)$ as

$$\eta u'(y-\rho\mathbf{b}_\pi)\mathbf{b}_\pi + (1-\eta)u'(y-\rho\mathbf{b}_L)\mathbf{b}_L = \psi_0$$

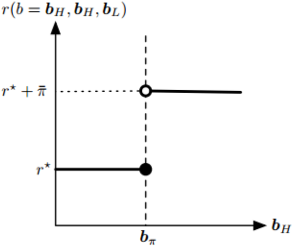
Best monotone equilibrium

1. Consumption,
$$C(b) = y - \rho b$$
2. Inflation,
$$\Pi(\mathbf{b}) = \begin{cases} 0 & \text{if } \mathbf{b}_H \leq \mathbf{b}_\pi(\mathbf{b}_L) \\ \bar{\pi} & \text{if } \mathbf{b}_H > \mathbf{b}_\pi(\mathbf{b}_L) \end{cases}$$
3. Interest rate schedule,
$$r(b,\mathbf{b}) = \begin{cases} \rho & \text{if } \mathbf{b}_H \leq \mathbf{b}_\pi(\mathbf{b}_L) \\ \rho + \bar{\pi} & \text{if } \mathbf{b}_H > \mathbf{b}_\pi(\mathbf{b}_L) \end{cases}$$
4. Value functions
$$V(b,\mathbf{b}) = \begin{cases} \frac{u(y-\rho b)}{\rho} & \text{if } \mathbf{b}_H \leq \mathbf{b}_\pi(\mathbf{b}_L) \\ \frac{u(y-\rho b)}{\rho} - \frac{\psi_0\bar{\pi}}{\rho} & \text{if } \mathbf{b}_H > \mathbf{b}_\pi(\mathbf{b}_L) \end{cases}$$

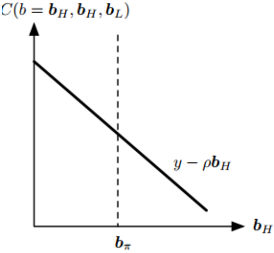
Best Monotone Equilibrium



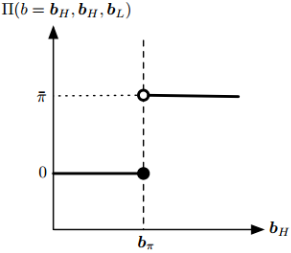
(a) Value Function



(b) Interest Rates



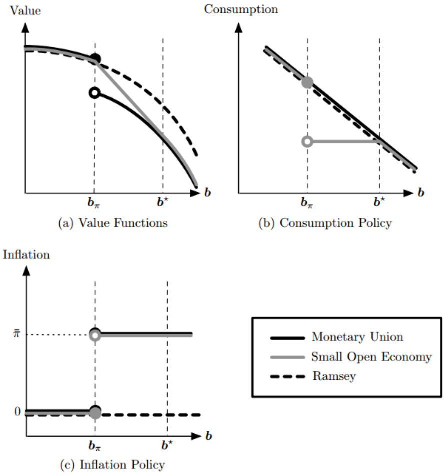
(c) Consumption Policy



(d) Inflation Policy

Fiscal Externalities

- Small decrease in debt around $\mathbf{b}_\pi$ leads to discrete jump in welfare.
- Opportunity not exploited due to lack of coordination between fiscal and monetary authorities.



Rollover Crises

- Coordination problem for creditors (Cole and Kehoe, 2000)
- If no rollover, repay during a grace period of length δ at fixed interest rate $\tilde{r}$
- May default at any point during the grace period if

$$\hat{V}^G(b, \tilde{r}; \tilde{\Pi}) \leq \underline{\hat{V}} \equiv \frac{u[(1-\chi)y]}{\rho}$$

- Define "crisis" and "safe" zones à la Cole and Kehoe

$$\mathbb{C} = \left\{ b \in \bar{\Omega} | b > \mathbf{b}_\lambda \right\}$$

- Sunspot: if $b \in \mathbb{C}$ creditors refuse to roll over maturing debt with Poisson arrival λ

Only source of uncertainty in the model.

Fiscal Authorities

Interest rate must compensate lenders for inflation and default risk,

$$r(b,\mathbf{b}) = \rho + \Pi(\mathbf{b}) + \lambda \mathbb{I}_{\mathbb{C}}(b)$$

Fiscal authority solves

$$\hat{V}(b) = \max_{c(t)} \int_0^\infty e^{-\rho t - \lambda \int_0^t \mathbb{I}_{\mathbb{C}}[b(s)]\mathrm{d}s} \left[u(c(t)) + \lambda \underline{\hat{V}} \right] \mathrm{d}t$$

subject to

$$\dot{b}(t) = c(t) - y + [r(b(t),\mathbf{b}(t)) - \Pi(\mathbf{b})]b(t)$$

$$b(0) = b, \quad \text{and } b(t) \in \bar{\Omega}$$

Interest rate now depends on $b(t)$

- Fiscal authority can save its way out of the crisis zone.

Monetary Authority

$$J(\mathbf{b}) = \max_{\pi(t)\in[0,\bar{\pi}]} \int_0^\infty \eta e^{-\rho t - \lambda \int_0^t \mathbb{I}_{\mathbb{C}}[b(s)]\mathrm{d}s} \left[u(C(\mathbf{b}(t))) + \lambda \underline{\hat{V}}\right] \mathrm{d}t$$
$$+ \int_0^\infty (1-\eta) e^{-\rho t} u(y)\mathrm{d}t - \psi_0 \int_0^\infty \eta e^{-\rho t - \lambda \int_0^t \mathbb{I}_{\mathbb{C}}[b(s)]\mathrm{d}s} \pi(t)\mathrm{d}t$$

subject to

$$\dot{\mathbf{b}}(t) = C(\mathbf{b}(t)) - y + [\rho + \Pi(\mathbf{b}(t)) + \lambda \mathbb{I}_{\mathbb{C}}(b(t)) - \pi(t)]\mathbf{b}(t)$$
$$\mathbf{b}(0) = \mathbf{b}$$

- Incentive to inflate away debt so as to help fiscal authority to exit the crisis zone.

RCE with Crises

Interest rate schedule r, value functions $(\hat{V}, \hat{V}^G, J)$, policy functions (C, C^G, Π), and threshold $\mathbf{b}_\lambda$ such that

1. $\hat{V}$ solves the fiscal authority's problem and C is its policy function
2. $\hat{V}^G$ solves the fiscal authority's grace period problem and C^G is the policy function
3. J solves the monetary authority's problem and Π is its policy function
4. Bond holders break even

$$r(b, \mathbf{b}) = \rho + \Pi(\mathbf{b}) + \lambda \mathbb{I}_{\mathbb{C}}(b)$$

5. $\hat{V}(b) \geq \underline{\hat{V}}$
6. $\hat{V}^G[b, r(b, \mathbf{b}); \tilde{\Pi}^e(., \mathbf{b})] < \underline{\hat{V}}$ for $b > \mathbf{b}_\lambda$ and all $\mathbf{b} \in \bar{\Omega}$.

Equilibrium Policies

- Fiscal policy

$$C(b) = \begin{cases} y - \rho b & \text{if } b \leq \mathbf{b}_\lambda \\ c_\lambda & \text{if } \mathbf{b}_\lambda < b \leq b^* \\ y - (\rho + \lambda) b & \text{if } b^* < b \end{cases}$$

and

$$\dot{b} = \begin{cases} -(\rho + \lambda)(b^* - b) & \text{if } b \in (\mathbf{b}_\lambda, b^*) \\ 0 & \text{otherwise} \end{cases}$$

where $c_\lambda(\mathbf{b}_\lambda)$ and $b^* = (y - c_\lambda)/(\rho + \lambda)$

- Monetary policy

$$\Pi(\mathbf{b}) = \begin{cases} 0 & \text{if } \mathbf{b} \leq \mathbf{b}_\pi \\ \bar{\pi} & \text{if } \mathbf{b}_\pi < \mathbf{b} \end{cases}$$

where

$$\mathbf{b}_\pi = \sup_b \left\{ b \in \bar{\Omega} \,\middle|\, u'(C(b)) b \leq \frac{\psi_0}{\eta} \right\}$$

Equilibrium Crisis Zone

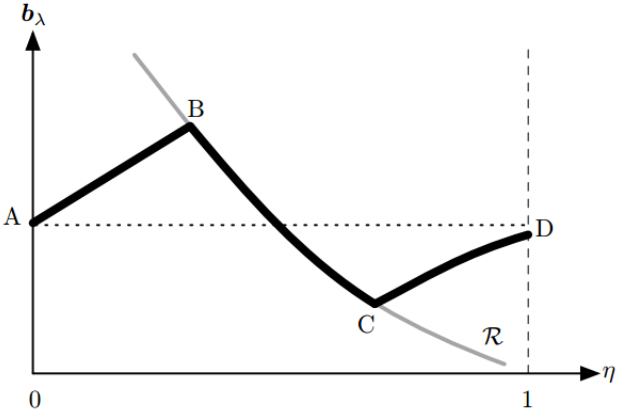
- Multiple equilibria corresponding to different thresholds $\mathbf{b}_\lambda$
- Restrict $\hat{V}^G - \underline{\hat{V}}$ in the safe zone via off-equilibrium beliefs

Equilibrium selection

- Suppose crisis occurs in the safe zone, debtors enter grace period
- Monetary authority sets inflation assuming debtors will repay
- Maximal inflationary support that is consistent with monetary authority's objective function
- No fiscal externality during the grace period, objectives are aligned

Debt Distribution

How does $\mathbf{b}_\lambda$ vary with η?



Optimal Composition of a Currency Union

Without crises:

- High debt country is strictly better off when other members have low debt
- This endogenously lowers the benefit of inflation for the monetary authority, allowing it to deliver the commitment outcome.

With rollover crises:

- High debt countries may be better off when there are other high debt countries.
- Crisis region is minimized at an interior $\eta > 0$
- High number of debtors makes it credible for the monetary authority to stand ready and inflate/assist in case of a rollover crisis