The Mystery of the Printing Press: Monetary Policy and Self-fulfilling Debt Crises

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Motivation: a bit of a debate

"Soaring rates in the European periphery [were] *a case of market panic* [...] [These countries] *no longer had a lender of last resort*, and were subject to potential liquidity crises."
— Paul Krugman "The Italian Miracle," April 29, 2013.

… debate

"Many people now accept the point [...] that [...] countries that have given up *the ability to print money* become vulnerable to *self-fulfilling panics* in a way that countries with their own currencies aren't...
—Paul Krugman "The Printing Press Mystery," August 17, 2011

...*Now come Corsetti and Dedola to argue that things are more complicated than that.* It's a pretty dense argument — in fact, *I'm going to need more coffee* before I make another try at getting the whole thing."
— Paul Krugman "Who has Draghi's back?" June 7, 2013.

…Draghi's speech

> "Public debt is in aggregate not higher in the euro area than in the US or Japan. [T]he *central bank* in those countries could act and has acted as *a backstop for government funding*. This is an important reason why markets spared their fiscal authorities *the loss of confidence* that constrained many euro area governments' market access."
> — Mario Draghi, Jackson Hole Speech, August 22, 2014.

Three questions

1. What enables a central bank to provide an effective monetary backstop to public funding, and rule out self-fulfilling sovereign default?

2. What is the required scale of interventions?

3. Does a monetary backstop eliminate bad equilibria without causing excessive inflation?

A key issue

- Because of political and institutional considerations, CBs typically fully responsible for their balance sheets.

- Under **budget separation** any loss in excess of the PDV of CB seigniorage revenue requires inflation to adjust residually and inefficiently.

What does this paper do?

- Analysis of monetary backstop as **equilibrium outcome:**
  - Feasible and welfare-improving for benevolent CB.

- Model of sovereign debt repudiation *under discretion*, via **haircuts** and/or **ex-post surprise inflation:**
  - Overt default can be **self-fulfilling** or **fundamental.**

- **Conventional** (inflation) **vs unconventional** (debt purchases) monetary policy.

How does a backstop work?

- CB liabilities *different* from public debt (Wallace 1981):
  - Claims to cash, free of ‘fear of outright default’.
- CB debt purchases effectively **swap default-risky sovereign debt with own liabilities, only exposed to inflation risk**.
- Large enough **debt purchases by CB lowers debt servicing cost,** up to making default a welfare-dominated option for the government, relative to fiscal adjustment.

Size of the backstop

Depending on financing need of the government possible that

- **Large backstop** rules out default altogether.

- **Intermediate** backstop rules out self-fulfilling default in 'normal times', but not default under fundamental fiscal stress (e.g., large recessions).
  - Debt purchases make CB vulnerable to losses due to fundamental default.

Backstop and Inflation

- Budget **consolidation** (*fiscal backing* to CB)
  - Policymakers optimize over all instruments, no inefficient tax and inflation adjustment ex post.
- Budget **separation** (CB *responsible for own losses*)
  - entails risk of large, inefficient inflation adjustment in case of fundamental default.
  - But then backstop may become a welfare-dominated option, thus not credible.

Literature: Sovereign default and self-fulfilling crises

- Exercise close to Calvo (1988), but *key differences*:
  - Fixed costs: multiplicity obtains over *range* of fundamentals.
  - Uncertainty: eqm *stability* and *comparative statics* (Interest bills increasing in stock of debt).
- Self-fulfilling crisis different from Cole & Kehoe (2000) — see Lorenzoni & Werning (2014).
- Backstop different from threat of inflationary debasement as in Aguiar, Amador, Farhi & Gopinath (2012).
- Recent papers: Bacchetta & VanWincoop (2014), Camous & Cooper (2014), D'Erasmo & Mendoza (2014), Navarro, Nicolini & Teles (2014), Nuño & Thomas (2014), Reis (2013), Roch & Uhlig (2011)...

Literature: Microfoundations of distortions and policy trade-offs

- Trade-offs taxation and inflationary finance (e.g. Barro 1983)
- Cost of inflation (e.g. Barro-Gordon, Woodford 2003)
- Discretionary monetary and fiscal policy (e.g. Diaz et al. 2008, Martin 2009)
- Commitment versus discretion (e.g. Persson & Tabellini 1993)
- "New style central banking" (Bassetto, Hall-Reis, Del Negro-Sims)

Road map

1. Setting the stage

2. The model

3. Results with/without inflation and backstops

4. Conclusions

SETTING THE STAGE

Setting the stage

- Economy with fundamental uncertainty. **States:** $i = H, A, L$: High/Average/Low with prob. $1 - \gamma$; $\gamma\mu$; $\gamma(1 - \mu)$.

- Consolidated (government plus central bank) budget constraint in nominal terms

$$(1-\theta)\frac{(1-\omega)\,BR_B}{1+\pi_i} + \frac{\mathcal{H}R_{\mathcal{H}}}{1+\pi_i} - (T_i - G) = \frac{(1-\omega')\,B' + \mathcal{H}'}{1+\pi_i}$$

where B is nominal debt, subject to default at the rate θ, $1 + \pi_i$, inflation, T real taxes and G real spending,
$\mathcal{H}$ are monetary liabilities issued by the central bank against a share ω of debt: $\mathcal{H} = \omega B$, possibly yielding an interest rate $R_{\mathcal{H}}$.
Key: Monetary liabilities are not subject to outright default.

Exogenous default rule

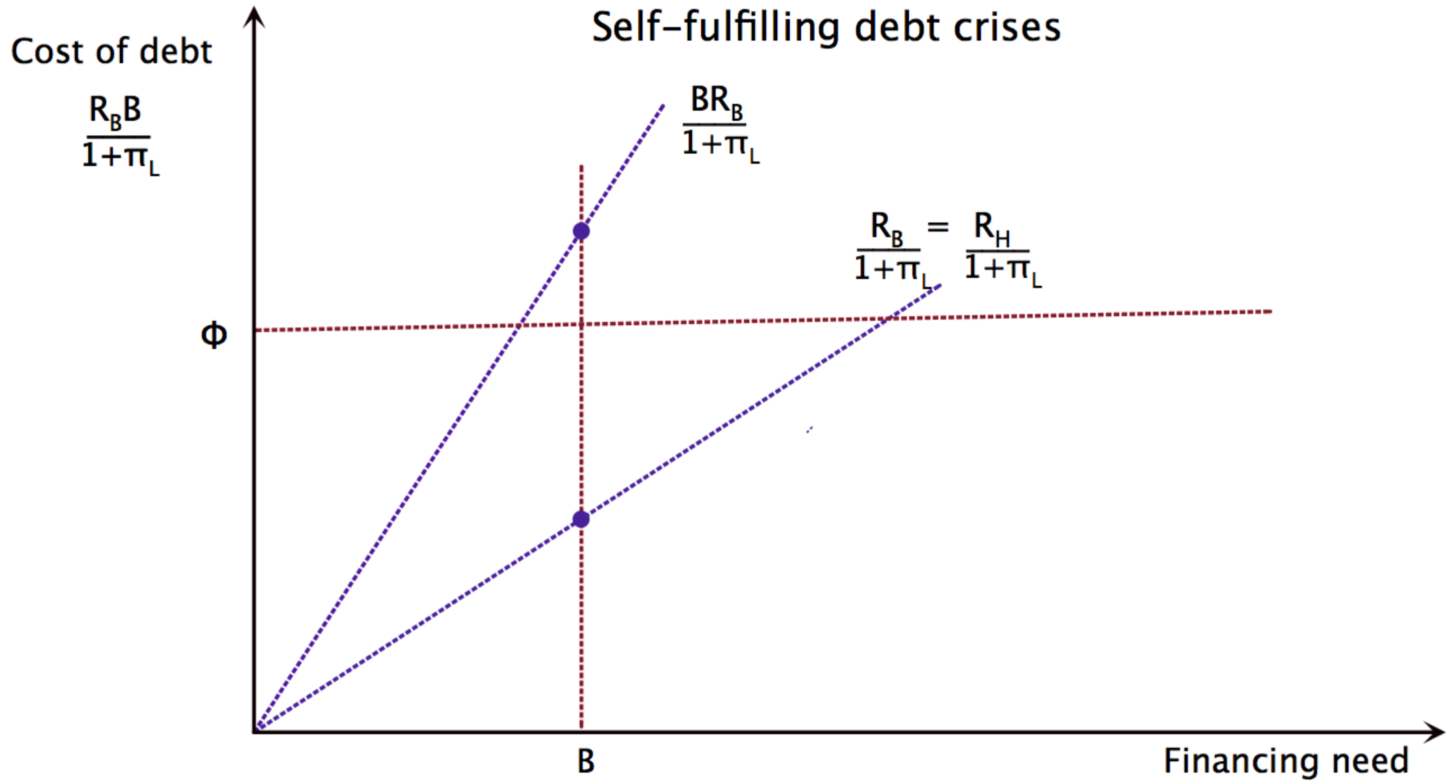
- With risk neutrality, equilibrium debt pricing

$$R_B = R\frac{1}{E\left(\frac{1-\theta}{1+\pi}\right)} \quad > \quad R_{\mathcal{H}} = R\frac{1}{E\left(\frac{1}{1+\pi}\right)}$$

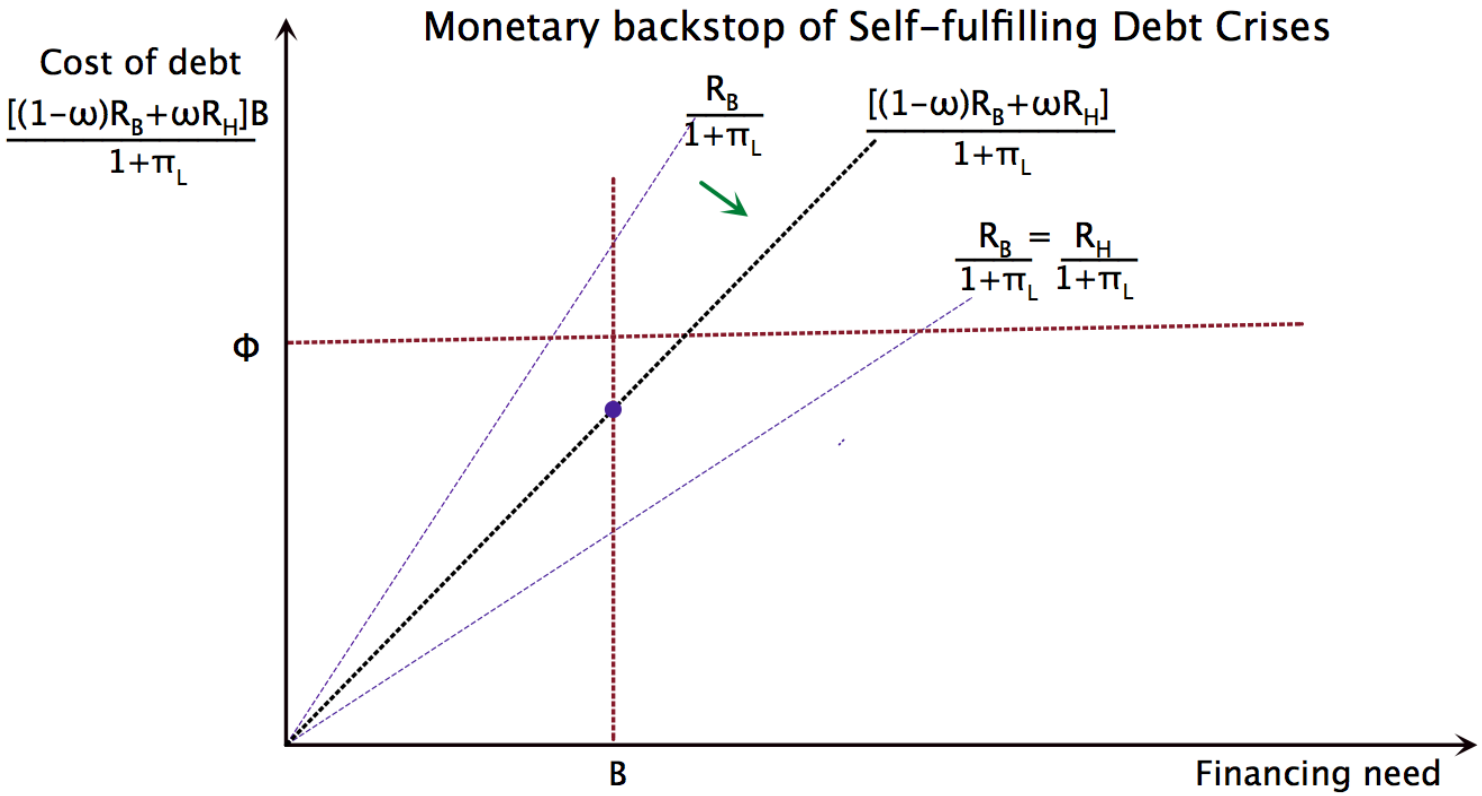
- Posit: government does not default if state H and A ($\theta = 0$).
If state L, default is either zero (θ_L=0) or 100 percent (θ_L=1) depending on whether debt costs BR_B are above some threshold Φ

$$R_B = \begin{cases} R\frac{1}{E\left(\frac{1}{1+\pi}\right)} = R_{\mathcal{H}} & \text{if } BR_B/P_i \leq \Phi \text{ in any state} \\ \\ R\frac{1}{E\left(\frac{1-\theta}{1+\pi}\right)} & \text{if } BR_B/P_L > \Phi \quad \text{if state } L \end{cases}$$

The logic of multiple equilibria: no backstop



The logic of backstop



Conventional (inflation) vs unconventional (balance sheet) policy

Conventional:

- Threat of ex-post bout of inflation could eliminate “bad equilibrium”.
- Inflation is costly: threat lacks credibility.
  - unless gov’t can dilute debasement costs e.g. by lengthening the maturity (or by virtue of a long maturity) of existing debt.

Uncoventional: CB can intervene in the debt market.

Key mechanism of unconventional policy

- Monetary liabilities of the central bank are always redeemable at face value.
  - one key difference relative to government bonds.
  - otherwise the nominal price of money would not be 1 and we should write $(1 - \theta_m)\,\mathcal{H}$.

- Backstop via unconventional policy rests on **return differential between monetary and government liabilities**: interventions lower the costs of debt and so alter the trade-off between raising the primary surplus and default.

In what follows:

- ‘Unconventional’ balance sheet policy.

- Endogenous default decision by discretionary policymakers
  - Backstop may affect the debt threshold and the nominal interest rate.

THE MODEL

A model revisiting Calvo 1988

- Equilibrium market rate (R_B) at which government borrows a *given* B in *domestic* currency, determined by expectations of (ex-post) fiscal and monetary choices.

- Two-period economy, Risk neutral agents,
  Fiscal authority and **central bank**: benevolent (same objective function) and discretionary. Act independently.

- Fundamental uncertainty: output in period 2 can be High, Average or Low i$=H, A, L$ with prob. $1-\gamma, \gamma\mu$ and $\gamma(1-\mu)$.

‘New style’ Central Banking (CB)

- In Period 1, may purchase ω share of B at some intervention rate $\bar{R}$, issuing interest-bearing reserves $\mathcal{H} = \omega B$ yielding $R_{\mathcal{H}}$ (Bassetto Hall-Reis Del Negro Sims)

- In period 2, sets inflation π_i (money demand as in Calvo 88) generating seigniorage :

$$\frac{\pi_i}{1+\pi_i}\kappa\left(\pi_i\right), \qquad i = L, H,$$

  and always honours its liabilities (=claim to cash) $\mathcal{H} \cdot R_{\mathcal{H}}$
  — $\mathcal{H}$ "intertemporal" demand for CB liabilities for **given price level** in first period, consistent with separate ex-post choice of inflation.

Timeline

- Period 1: **Risk-neutral agents** invest their wealth in
  (i) B, at the *real* return R_B— spread over *safe* rate R—,
  (ii) monetary liabilities $\mathcal{H}$ at the rate $R_{\mathcal{H}}$, and (iii) safe asset K at R.
  The **central bank** may purchase public debt ωB at $\bar{R}$.

- Period 2: *Uncertainty* over economic state resolved.
  Discretionary government, taking ω, R_B, $R_{\mathcal{H}}$ and inflation rate π_i as given, optimizes over *taxes* T_i, and *default rate* $\theta_i \in [0, 1]$
  Discretionary central bank, taking fiscal instruments as given, sets inflation π_i.
  Agents consume their wealth.

Policy instruments and distortions

- **Taxation**: state-dependent **convex output costs —** *higher* and *growing faster* in worse states

$$\begin{aligned} z\left(T;Y_L\right) &> z\left(T;Y_A\right) > z(T;Y_H), \\ z'\left(T;Y_L\right) &> z'\left(T;Y_A\right) > z'(T;Y_H). \end{aligned}$$

- **Default: fixed** output costs ξ_θ and **variable** (budget) costs, proportional to size of haircut

$$\alpha\left(1-\omega\right)\theta B, \ \textit{and} \ \alpha_{CB}\theta\omega B \qquad \alpha_{CB} \leq \alpha < 1$$

hereafter $\alpha_{CB} = 0$ for expositional simplicity.

- **Inflation:** convex output cost $C\left(\pi_i\right)$, iso-morphic to $z\left(T;Y_i\right)$.

Budget constraints

- Central bank transfers to the fiscal authority:

$$\mathcal{T}_i = \frac{\pi_i}{1+\pi_i}\kappa + \left(\frac{(1-\theta_i)\,\bar{R}}{1+\pi_i} - \frac{R_{\mathcal{H}}}{1+\pi_i} \right) \omega B$$

Budget separation: $\mathcal{T}_i \geq \bar{\mathcal{T}} = 0$.

Budget consolidation (note interest paid to CB $\bar{R}$ is a *wash*):

$$T_i - G + \frac{\pi_i}{1+\pi_i}\kappa \;=\; \overbrace{\frac{R_{\mathcal{H}}}{1+\pi_i}\omega B}^{\text{interest bill of the CB}}$$

$$+\; \overbrace{\left[1-\theta_i\,(1-\alpha)\right]\frac{\bar{R}_B}{1+\pi_i}\,(1-\omega)\,B}^{\text{gov't interest bill net of default costs}}$$

Utility and equilibrium interest rates

- Under risk-neutrality, utility

$$U_i = C_i = \overbrace{\left[Y_i - z\left(T_i; Y_i\right) - \mathcal{C}\left(\pi_i\right) - \xi_\theta\right]}^{\text{net output}} - T_i - \frac{\pi_i}{1+\pi_i}\kappa$$

$$+ \overbrace{\left(1-\theta_i\right)\frac{\left(1-\omega\right)BR_B}{1+\pi_i} + \frac{\mathcal{H}R_{\mathcal{H}}}{1+\pi_i} + KR}^{\text{assets income}}$$

asset pricing (note: $R_B \geq R_{\mathcal{H}}$)

$$R_B = \frac{R}{(1-\gamma)\left(\frac{\mu}{1+\widetilde{\pi}_H} + \frac{1-\mu}{1+\widetilde{\pi}_L}\right) + \gamma\left[\mu\left(\frac{1-\theta_H}{1+\pi_H}\right) + (1-\mu)\left(\frac{1-\theta_L}{1+\pi_L}\right)\right]} \geq R_{\mathcal{H}} = \frac{R}{E\left(\frac{1}{1+\pi}\right)}$$

Lagrangian (ignoring boundary constraints)

$$L\left(T_i,\pi_i,\theta_i,\tau_i\right) =$$

$$Y_i - z\left(T_{i,}Y_i\right) + KR - c\left(\pi_i\right) - T_i - \frac{\pi_i}{1+\pi_i}\kappa + \frac{1-\theta_i}{1+\pi_i}\left(1-\omega\right)B\tilde{R} + \frac{1+i}{1+\pi_i}\omega B$$

$$+\lambda_i^{GOV}\cdot\left[T_i - G - \frac{1-\theta_i\left(1-\alpha\right)}{1+\pi_i}\left(1-\omega\right)B\tilde{R} - \frac{1-\theta_i\left(1-\alpha_{CB}\right)}{1+\pi_i}\omega B\bar{R} + \tau_i\right]$$

$$+\lambda_i^{CB}\cdot\left[\frac{\pi_i}{1+\pi_i}\kappa + \frac{1-\theta_i}{1+\pi_i}\omega B\bar{R} - \frac{1+i}{1+\pi_i}\omega B - \tau_i\right] \quad + \lambda_i^{CONS}\cdot\left[-\tau_i\right]$$

where $\lambda_i^{GOV}, \lambda_i^{CB}, \lambda_i^{CONS}$ are the Lagrange multipliers for, respectively, the government and central bank's budget constraints and the non-negativity constraint on transfers to the central bank.

What follows focus on the case $\lambda_i^{CONS} = 0$.

Discretionary fiscal plan: choice of default

Notation: a ˆ denotes allocation conditional on optimal interior default $\widehat{\theta} < 1$.

- Gov't defaults when $U_i(\theta_i > 0) \geq U_i(\theta_i = 0)$, i.e. default costs lower than incremental distortions from raising taxes and inflation to service debt in full

$$\text{default if}: \xi_\theta + [\alpha(1-\omega) B R_B] \frac{\widehat{\theta}_i B}{1+\widehat{\pi}_i}$$
$$\leq z(T_i; Y_i) - z\left(\widehat{T}_i; Y_i\right) + c(\pi_i) - c(\widehat{\pi}_i)$$

Because of fixed costs ξ_θ, optimal default occurs at a minimum rate $\underline{\theta}_i > 0$:

$$\text{default if} \quad \widehat{\theta}_i \geq \underline{\theta}_i \qquad \theta_i \in [\underline{\theta}_i, 1]$$

Discretionary fiscal plan: taxes and default rates

- If no ($\theta_i = 0$) or complete ($\theta_i = 1$) default, taxes adjust residually.

$$T_i = G - \frac{\pi_i}{1+\pi_i}\kappa + [1 - \theta_i (1-\alpha)] \frac{R_B}{1+\pi_i} B \qquad \text{if} \;\; \theta = 0 \text{ or } \theta = 1$$

If constraint $\theta_i \leq 1$ not binding, gov't optimally trade-offs distortions from taxation with variable costs of default setting $\widehat{T}_i$. $\widehat{\theta}_i$ determined by budget constraint.

$$z'(\widehat{T}_i; Y_i) = \frac{\alpha}{1-\alpha} \qquad \text{if } \theta < 1$$

Discretionary conventional monetary policy

- Equate inflation marginal cost and benefit (lower taxes):

$$
\begin{aligned}
(1+\pi_i)^2 \mathcal{C}'(\pi_i) &= z'(T_i;Y_i)(BR_B+\kappa) - \theta_i BR_B\left[\alpha - z'(T_i;Y_i)(1-\alpha)\right] \\
&: \text{ if } \theta = 0 \text{ or } \theta = 1 \\
&= \frac{\alpha}{1-\alpha}\left[(1-\omega)BR_B + \omega R_{\mathcal{H}} B + \kappa\right] \\
&: \text{ if } \theta < 1
\end{aligned}
$$

Equilibrium and plan ahead

Nash equilibrium is defined as

Under budget consolidation:

1.	No monetary policy	No backstop
2.	Conventional monetary policy	No backstop
3.	No monetary policy	"Backstop"=commitment to repay ωBR
4.	Complete model	

NO MONETARY POLICY, NO BACKSTOP

Stable multiple equilibria

Focus on Nash where size of B and probabilities are such that

1. Fundamental default may or may not occur in state L under fiscal stress, but there is no fundamental reason for defaulting in states A, H.

   - B not too large (for $i = H, A : \widehat{\theta}_i < \underline{\widehat{\theta}}_i$; but $\widehat{\theta}_L \geq \underline{\widehat{\theta}}_L$)

2. Equilibria are well-behaved, i.e., "stable" by the Walrasian criterion: small increase in B does not lower notional interest rate (i.e., it should not raise bond price)—see Lorenzoni and Werning (2013): $1 - \gamma > \alpha, 1 > \mu > 0$.

3. Weak monotonicity: Default: N, N&L, L, L&A

Nash equilibria in pure strategies

- Proposition 1: **Multiple equilibria if debt in the range:**

$$\frac{1}{1-\underline{\theta}_L(1-\alpha)}\frac{\hat{T}_L-G}{R} > B \geq \frac{1-\gamma(1-\mu)\underline{\theta}_L}{1-\underline{\theta}_L(1-\alpha)}\frac{\hat{T}_L-G}{R}$$

$$\frac{1-\gamma(1-\mu)}{1-\underline{\theta}_A(1-\alpha)}\frac{\hat{T}_A-G}{R} > B \geq \frac{1-\gamma(1-\mu)-\gamma\mu\underline{\theta}_A}{1-\underline{\theta}_A(1-\alpha)}\left(\hat{T}_A-G\right)$$

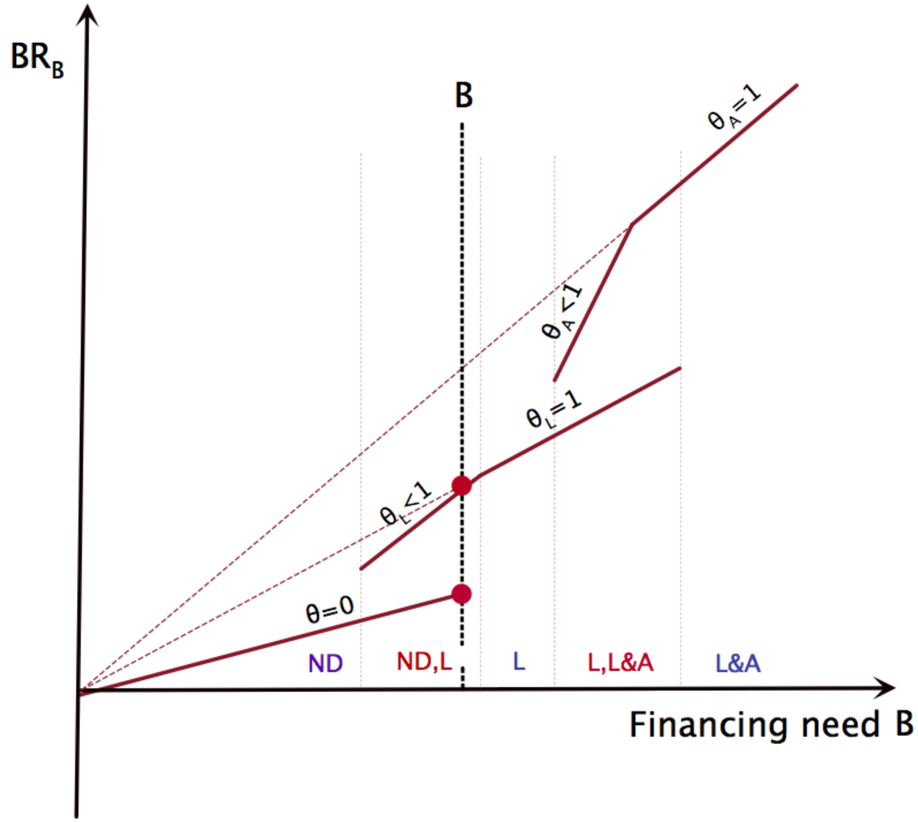
Stable equilibria

- Provided $1-\gamma > \alpha$ (probability of being repaid in the High state is high enough), debt servicing *increases* in debt level:

$$BR_B = \begin{cases} BR & \theta_L = \theta_A = 0 \\ \frac{(1-\alpha)RB-\gamma(1-\mu)\left(\widehat{T}_L-G\right)}{1-\alpha-\gamma(1-\mu)} & \underline{\theta}_L \leq \widehat{\theta}_L < 1, \theta_A = 0 \\ \frac{BR}{1-\gamma(1-\mu)} & \widehat{\theta}_L = 1, \theta_A = 0 \\ \frac{(1-\alpha)RB-\gamma\mu\left(\widehat{T}_A-G\right)}{1-\alpha-\gamma} & \widehat{\theta}_L = 1, 0 < \widehat{\theta}_A < 1 \end{cases}$$

Note: In Calvo 88, interest rate *decreasing* in B, and only **unstable** non-fundamental equilibrium (since $\gamma = 1$).
Our model **also** features unstable multiple equilibria à la Calvo.

Nash equilibria in pure strategies: two ranges of multiplicity



Tax vs default distortions (role of $Z\left(\right)$)

- If distortions do not increase sharply in taxation, the government may find it optimal to raise primary surpluses more before reaching the default point. But then haircuts are larger.

- With $\omega = 0$, the minimum threshold $\underline{\theta}_i < 1$ at which partial default is optimal solves

$$\xi_\theta + \frac{\alpha \underline{\theta}_i}{1 - (1-\alpha)\underline{\theta}_i}\left(\hat{T}_i - G\right) = z\left(\hat{T}_i + \frac{(1-\alpha)\underline{\theta}_i}{1-(1-\alpha)\underline{\theta}_i}\left(\hat{T}_i - G\right), Y_i\right) - \frac{\alpha}{1-\alpha}$$

The flatter $z\left(.\right)$ the higher $\underline{\theta}_i$.

CONVENTIONAL (INFLATION) MONETARY POLICY, NO BACKSTOP

Multiplicity in haircut rates but not in inflation (role of $C()$)

- With *convex* cost $\mathcal{C}(\pi_i)$, inflation is uniquely determined given θ (Lemma 2)—rearranging the f.o.c.:

$$\frac{\alpha}{1-\alpha}\frac{BR_B+\kappa}{(1+\widehat{\pi}_i)^2}=\mathcal{C}'(\widehat{\pi}_i)$$

  Multiplicity in π possible if costs bounded (Calvo 88).

- **Multiple stable** equilibria in θ of the same kind as in the economy with non-indexed debt (Prop. 3).

- Ex-post inflation surprises affect threshold ('*vulnerability*' range), but cost of inflation rules out debt monetization.

NO MONETARY POLICY, “BACKSTOP”

De facto commitment to repay ωBR

To build intuition: As long as optimal default if partial, i.e. $\widehat{\theta}_L \geq \underline{\theta}_L$, a marginally increase in ω actually raises the optimal rate of default $\widehat{\theta}_L$

$$\widehat{\theta}_L = \frac{RB - \left(\widehat{T}_L - G\right)}{\{(1-\alpha) - \omega\left[(1-\alpha) - \gamma\left(1-\mu\right)\right]\} - \gamma\left(1-\mu\right)\left(\widehat{T}_L - G\right)} \geq \underline{\theta}_L$$

as well as the minimum default threshold $\underline{\theta}_L$:

$$\xi_\theta + \alpha \frac{\left(\hat{T}_i - G\right) - \omega BR}{1 - \underline{\theta}_L\left(1-\alpha\right)} \underline{\theta}_L$$
$$= z\left(\left(1-\alpha\right)\underline{\theta}_L \frac{\left(\hat{T}_i - G\right) - \omega BR}{\left(1 - \underline{\theta}_L\left(1-\alpha\right)\right)} + \widehat{T}_L; Y_i\right) - z(\widehat{T}_L; Y_L)$$

Because of variable costs of default, the government reoptimizes and ω moves the terms of the default decision the "wrong way".

De facto commitment to repay ωBR: insight from fixed costs only

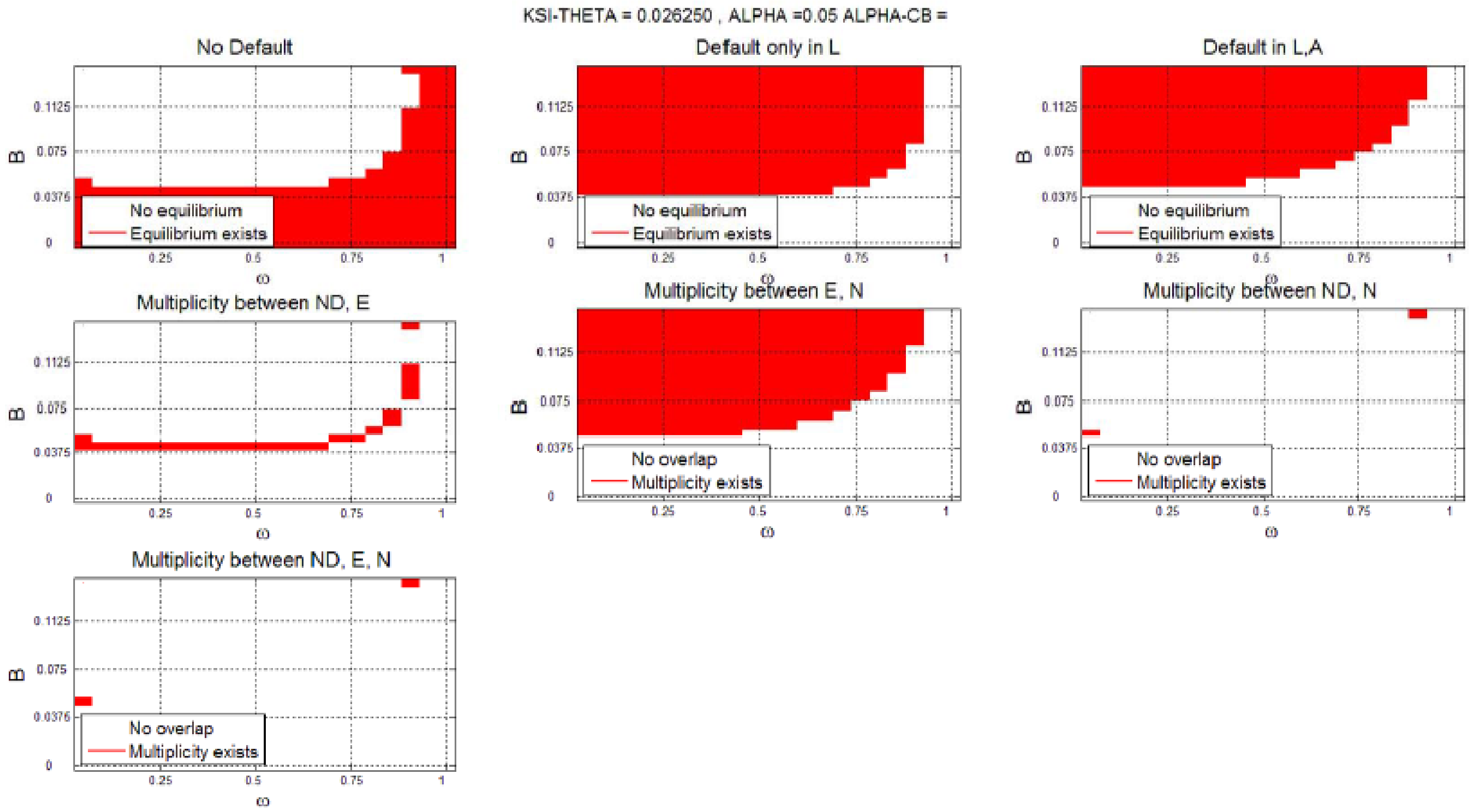
If $\alpha = 0$, θ is no longer elastic to ω: the haircut rate is fixed to its maximum 100 percent

ω raises the minimum level of debt at which the country default $\underline{B}_L$

$$\begin{aligned}\xi_\theta \;=\;& z\left(G + \frac{R\underline{B}_L - \gamma\left(1-\mu\right)\omega R\underline{B}_L}{1-\gamma\left(1-\mu\right)}, Y_L\right) - \\ & z\left(G + \frac{\left(1-\underline{\theta}_L\right)R\underline{B}_L + \left(1-\gamma\left(1-\mu\right)\right)\omega\underline{B}_L R}{1-\gamma\left(1-\mu\right)}, Y_L\right)\end{aligned}$$

Intuitively, with $\alpha > 0$, interventions become effective when large enough to switch the trade-offs faced by the government, from (a) marginal adjustment in the tax and default rates, to (ii) complete default with residual adjustment in taxation.

MONETARY POLICY, AND BACKSTOP


KSI-THETA = 0.026250 , ALPHA =0.05 ALPHA-CB =
No Default
Default only in L
Default in L,A
Multiplicity between ND, E
Multiplicity between E, N
Multiplicity between ND, N
Multiplicity between ND, E, N
No equilibrium
Equilibrium exists
No overlap
Multiplicity exists
B
ω
0
0.0376
0.075
0.1125
0.25
0.5
0.75
1

In the figure

1. At relatively low debt: no default.

2. More debt: multiplicity between ND and L default.

    (a) intermediate ω eliminates the bad equilibrium

3. Higher debt: multiplicity between L and L& A,

    (a) intermediate ω eliminates default in A but not in L

    (b) larger ω eliminates default

- Balance sheet losses under budget separation an issue for 3a.

Under budget separation and binding transfer constraint:

Optimal fiscal policy:

$$T_i = G + [1 - \theta_i (1 - \alpha)] \frac{R_B}{1 + \pi_i} B \qquad \text{if } \theta = 0 \text{ or } \theta = 1$$

$$z'(\widehat{T}_i; Y_i) = \frac{\alpha R_B + \lambda^{GOV} \cdot \omega \bar{R}}{(1 - \alpha)} \qquad \text{if } \theta < 1$$

Inflation is determined residually, by the CB budget constraint:

$$\frac{\pi_i}{1 + \pi_i} \kappa + \left(\frac{(1 - \theta_i) \bar{R}}{1 + \pi_i} - \frac{R_{\mathcal{H}}}{1 + \pi_i} \right) \omega B = 0$$

Binding budget separation (CB responsible for own losses)

- Risk of large, inefficient inflation adjustment in case of fundamental default, that could make backstop a welfare-dominated option.
- Conjecture: Partial **backstop still credible if violations** small enough. If required adjustment in inflation small, equilibrium with interventions still better than non-fundamental equilibrium.

Conclusions

- Support for CB backstop, but for different reasons than often invoked:
  - Does not rely on open-ended inflationary financing
  - Crucial: CB issues nominal liabilities free of default fears.
  - Facilitated when the fiscal and monetary authorities share same objectives.
- Open issues, e.g., debt dynamics, moral hazard.

Some lessons for a currency area

- With essentially independent states, it may be possible that national governments pursue different, inward-looking objectives and/or be adverse to extending large-scale fiscal backing to the common central bank.
  - Ability to impose conditionality/default costs on CB can be important here.

- But little reason for a common central bank not to have the capability to engineer successful interventions with little inflation consequences under right conditions.

FAQs

1. Is the setup consistent with simple choice-theoretic framework? Yes.

2. Does multiplicity strictly depend on the way we model the debt market? Not really.

FAQ 1. Choice-theoretic framework

- Consistent with agents utility maximization: $c - h(n)$

$$
\begin{aligned}
(1-\tau)\, w &= h'(n) => \frac{\partial n}{\partial \tau} = -\frac{w}{h''(n)} \\
&=> \\
z'(T) &= -\frac{\frac{\tau}{n}\frac{\partial n}{\partial \tau}}{1+\frac{\tau}{n}\frac{\partial n}{\partial \tau}} = \frac{\alpha}{1-\alpha}
\end{aligned}
$$

Optimal to borrow to smooth tax distortions.

FAQ 2. Multiplicity and debt markets

- Chamon (2007), Lorenzoni & Werning (2014):
  - **Calvo**: Gov't picks borrowing B, expectations determine face value BR_B
    $B' = \widetilde{R}B - (T - G)$
  - **Cole-Kehoe**: Gov't picks face value D, expectations determine actual borrowing D/R_B
    $qD' = D - (T - G)$
- Self-fulfilling equilibria in **both** cases:
  - *Roll-over* crisis in Cole-Kehoe, but *no* Calvo crisis.
  - LW: All about **commitment** *not* to issue more bonds, but adjust surplus.

$\mathcal{M}$ vs $\mathcal{H}$: insight from the (zero) lower bound...

- When (risk-free) nominal rate at ZLB, CB able to issue money to buy government paper at will:
  - If *non-fundamental default* priced in sovereign rates, purchases arbitrarily *reduce* the cost of servicing the debt and *eliminate* self-fulfilling default.
  - However, to avoid *undesirable inflation developments*, fiscal and monetary policies have to deal with increased money stock in the *future*.

...the general case in the model

- Unconventional policy in our model is an *extension* to the case in which CB liabilities issued at equilibrium nominal rate, **consistent** with expected inflation.

- Several recent papers model **size** of CB balance sheet *distinct* from **inflation control**:
  - CB interest-bearing reserves in Hall-Reis (2013), Del Negro-Sims (2014),...