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

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Disclaimer: The views expressed in this paper are our own, and do not reflect those of the European Central Bank or the Eurosystem, or any institution to which we are affiliated.
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.”
... 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...

...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).


• Backstop different from threat of inflationary debasement as in Aguiar, Amador, Farhi & Gopinath (2012).

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

$$\left(1 - \theta\right) \frac{(1 - \omega) BR} {1 + \pi_i} + \frac{HR} {1 + \pi_i} - (T - G) = \frac{(1 - \omega') B' + H'} {1 + \pi_i}$$

where $B$ is nominal debt, subject to default at the rate $\theta, 1 + \pi_i$, inflation, $T$ real taxes and $G$ real spending, $H$ are monetary liabilities issued by the central bank against a share $\omega$ of debt: $H = \omega B$, possibly yielding an interest rate $R_H$.

Key: Monetary liabilities are not subject to outright default.
Exogenous default rule

- With risk neutrality, equilibrium debt pricing

\[ R_B = R \frac{1}{E \left( \frac{1-\theta}{1+\pi} \right)} \quad > \quad R_H = R \frac{1}{E \left( \frac{1}{1+\pi} \right)} \]

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

\[
R_B = \begin{cases} 
R \frac{1}{E \left( \frac{1-\theta}{1+\pi} \right)} = R_H & \text{if } B R_B / P_i \leq \Phi \text{ in any state} \\
R \frac{1}{E \left( \frac{1-\theta}{1+\pi} \right)} & \text{if } B R_B / P_L > \Phi \text{ if state } L 
\end{cases}
\]
The logic of multiple equilibria: no backstop

\[ \frac{R_B B}{1+\pi_L} \]

Self-fulfilling debt crises

\[ \frac{B R_B}{1+\pi_L} \]

\[ \frac{R_B}{1+\pi_L} = \frac{R_H}{1+\pi_L} \]
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 \((1 - \theta_m) H\).

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

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

\[
\frac{\pi_i}{1 + \pi_i} \kappa(\pi_i), \quad i = L, H,
\]

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 $\omega B$ at $\bar{R}$.

- **Period 2:** Uncertainty over economic state resolved.
  Discretionary government, taking $\omega, R_B, R_{\mathcal{H}}$ and inflation rate $\pi_i$ 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 $\pi_i$.
  Agents consume their wealth.
Policy instruments and distortions

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

\[ z(T; Y_L) > z(T; Y_A) > z(T; Y_H), \]
\[ z'(T; Y_L) > z'(T; Y_A) > z'(T; Y_H). \]

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

\[ \alpha (1 - \omega) \theta B, \quad \text{and} \quad \alpha_{CB} \theta \omega B \quad \alpha_{CB} \leq \alpha < 1 \]

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

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

- Central bank transfers to the fiscal authority:

\[ T_i = \frac{\pi_i}{1 + \pi_i} \kappa + \left( \frac{(1 - \theta_i) \bar{R}}{1 + \pi_i} - \frac{R_H}{1 + \pi_i} \right) \omega B \]

Budget separation: \( T_i \geq \bar{T} = 0 \).

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

\[ T_i - G + \frac{\pi_i}{1 + \pi_i} \kappa = \underbrace{\frac{R_H}{1 + \pi_i} \omega B}_{\text{interest bill of the CB}} \]

\[ + \left[ 1 - \theta_i (1 - \alpha) \right] \frac{\bar{R}_B}{1 + \pi_i} (1 - \omega) B \]

\[ \text{gov't interest bill net of default costs} \]
Utility and equilibrium interest rates

- Under risk-neutrality, utility

\[
U_i = C_i = \left[ Y_i - z(T_i, Y_i) - C(\pi_i) - \xi_{\theta} \right] - T_i - \frac{\pi_i}{1 + \pi_i} \kappa \\
+ (1 - \theta_i) \frac{(1 - \omega) BR_B}{1 + \pi_i} + \frac{HHR_H}{1 + \pi_i} + KR
\]

asset pricing (note: \( R_B \geq R_H \))

\[
R_B = \frac{R}{(1 - \gamma) \left( \frac{\mu}{1 + \pi_H} + \frac{1 - \mu}{1 + \pi_L} \right) + \gamma \left[ \mu \left( \frac{1 - \theta H}{1 + \pi_H} \right) + (1 - \mu) \left( \frac{1 - \theta L}{1 + \pi_L} \right) \right]} \geq R_H = \frac{R}{E \left( \frac{1}{1 + \pi} \right)}
\]
Lagrangian (ignoring boundary constraints)

\[ L(T_i, \pi_i, \theta_i, \tau_i) = \]
\[ Y_i - z(T_i, Y_i) + K R - c(\pi_i) - T_i - \frac{\pi_i}{1 + \pi_i} \kappa + \frac{1 - \theta_i}{1 + \pi_i} (1 - \omega) B \tilde{R} + \frac{1 + i}{1 + \pi_i} \omega B \]
\[ + \lambda_{i}^{GOV} \cdot \left[ T_i - G - \frac{1 - \theta_i (1 - \alpha)}{1 + \pi_i} (1 - \omega) B \tilde{R} - \frac{1 - \theta_i (1 - \alpha_{CB})}{1 + \pi_i} \omega B \tilde{R} + \tau_i \right] \]
\[ + \lambda_{i}^{CB} \cdot \left[ \frac{\pi_i}{1 + \pi_i} \kappa + \frac{1 - \theta_i}{1 + \pi_i} \omega B \tilde{R} - \frac{1 + i}{1 + \pi_i} \omega B - \tau_i \right] + \lambda_{i}^{CONS} \cdot [-\tau_i] \]

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 ^ denotes allocation conditional on optimal interior default \( \hat{\theta} < 1 \).

- 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 default if:

\[
\xi_\theta + [\alpha (1 - \omega) BR_B] \frac{\hat{\theta}_i B}{1 + \hat{\pi}_i} \\
\leq z (T_i; Y_i) - z (\hat{T}_i; Y_i) + c (\pi_i) - c (\hat{\pi}_i)
\]

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

default if \( \hat{\theta}_i \geq \underline{\theta}_i \) \( \underline{\theta}_i \in [\theta_i, 1] \)
Discretionary fiscal plan: taxes and default rates

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

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

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

\[ z'(\hat{T}_i; Y_i) = \frac{\alpha}{1 - \alpha} \quad \text{if } \theta < 1 \]
Discretionary conventional monetary policy

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

\[
(1 + \pi_i)^2 C'(\pi_i) = z'(T_i; Y_i) (BR_B + \kappa) - \theta_i BR_B [\alpha - z'(T_i; Y_i) (1 - \alpha)] \\
: \text{if } \theta = 0 \text{ or } \theta = 1
\]

\[
= \frac{\alpha}{1 - \alpha} [(1 - \omega) BR_B + \omega R_H B + \kappa] \\
: \text{if } \theta < 1
\]
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 $\omega BR$

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 $i = H, A: \hat{\theta}_i < \hat{\theta}_L$; but $\hat{\theta}_L \geq \hat{\theta}_L$)

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:**

\[
\frac{1}{1 - \theta_L (1 - \alpha)} \frac{\hat{T}_L - G}{R} > B \geq \frac{1 - \gamma (1 - \mu) \theta_L}{1 - \theta_L (1 - \alpha)} \frac{\hat{T}_L - G}{R}
\]

\[
\frac{1 - \gamma (1 - \mu)}{1 - \theta_A (1 - \alpha)} \frac{\hat{T}_A - G}{R} > B \geq \frac{1 - \gamma (1 - \mu) - \gamma \mu \theta_A}{1 - \theta_A (1 - \alpha)} (\hat{T}_A - G)
\]
Stable equilibria

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

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

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 $Z()$)

- 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 $\theta_i < 1$ at which partial default is optimal solves

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

The flatter $z(.)$ the higher $\theta_i$. 

\[z\]
CONVENTIONAL (INFLATION) MONETARY POLICY, NO BACKSTOP
Multiplicity in haircut rates but not in inflation (role of $C()$)

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

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

Multiplicity in $\pi$ possible if costs bounded (Calvo 88).

- **Multiple stable** equilibria in $\theta$ 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 $\omega BR$

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

$$\hat{\theta}_L = \frac{RB - (\hat{T}_L - G)}{\{(1 - \alpha) - \omega [(1 - \alpha) - \gamma (1 - \mu)]\} - \gamma (1 - \mu) (\hat{T}_L - G)} \geq \theta_L$$

as well as the minimum default threshold $\theta_L$:

$$\xi_{\theta} + \alpha \left( \frac{\hat{T}_i - G}{1 - \theta_L (1 - \alpha)} \right)^{\theta_L}$$

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

Because of variable costs of default, the government reoptimizes and $\omega$ moves the terms of the default decision the “wrong way”.

De facto commitment to repay $\omega BR$: insight from fixed costs only

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

$\omega$ raises the minimum level of debt at which the country default $BL$

$$\xi_\theta = z \left( G + \frac{RB_L - \gamma (1 - \mu) \omega RB_L}{1 - \gamma (1 - \mu)}, Y_L \right) - z \left( G + \frac{(1 - \theta_L) RB_L + (1 - \gamma (1 - \mu)) \omega B_L R}{1 - \gamma (1 - \mu)}, Y_L \right)$$

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
In the figure

1. At relatively low debt: no default.

   (a) intermediate \( \omega \) eliminates the bad equilibrium

3. Higher debt: multiplicity between L and L& A,
   (a) intermediate \( \omega \) eliminates default in A but not in L
   (b) larger \( \omega \) eliminates default
- Balance sheet losses under budget separation an issue for 3a.
Under budget separation and binding transfer constraint:

Optimal fiscal policy:

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

\[ z^i(\hat{T}_i; Y_i) = \frac{\alpha R_B + \lambda^{GOV} \cdot \omega \bar{R}}{(1 - \alpha)} \quad \text{if } \theta < 1 \]

Inflation is determined residually, by the CB budget constraint:

\[ \frac{\pi_i}{1 + \pi_i} \kappa + \left( \frac{(1 - \theta_i) \bar{R}}{1 + \pi_i} - \frac{R_H}{1 + \pi_i} \right) \omega B = 0 \]
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: \( c - h(n) \)

\[
(1 - \tau)w = h'(n) = \frac{\partial n}{\partial \tau} = -\frac{w}{h''(n)}
\]

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 \( BR_B \)
    \[ B' = \tilde{R}B - (T - G) \]
  - **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),...