International Reserve Management under Rollover Crises

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Motivation

To reduce the vulnerability to a debt crisis:

- Should the government reduce the debt or increase reserves?

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Answer unclear:

- Reserves provide liquidity

  ....but reducing debt may lower vulnerability more

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    - Sunspot shocks, deterministic income
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Preview:

- If heavily indebted, optimal to initially reduce debt and keep zero reserves
- Once debt is reduced sufficiently, optimal to increase debt and accumulate reserves
- Borrowing to accumulate reserves can reduce spreads

Model

Environment

- Discrete time, infinite horizon. Constant endowment: $y_t = y$
- Government trades two assets ...
  - short-term risk-free reserves, a
  - long-term defaultable debt, b
- Risk-neutral deep pocket international investors:
  - Discount future flows at rate r, assume $\beta(1 + r) = 1$

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- Risk-neutral deep pocket international investors:
  - Discount future flows at rate r, assume $\beta(1 + r) = 1$
- Markov equilibrium w/ Cole-Kehoe (2000) timing:
  - Borrowing at the beginning of the period
  - Settlement (repay/default) at the end

Government

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) - \phi d_t]$$

where $d_t = 0$ (1) denotes repayment (default)

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- If the government repays:

$$c_t = \underbrace{y + a_t - \kappa b_t}_{\text{resources avail.}} - \underbrace{\frac{a_{t+1}}{1+r}}_{\text{reserve purchases}} + \underbrace{q_t \left[b_{t+1} - (1-\delta) b_t\right]}_{\text{debt issuance}}$$

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  where maturity indexed by δ and κ normalized so that bond price $1/(1+r)$ absent default risk

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- If the government defaults:

$$c_t = y + a_t - \frac{a_{t+1}}{1+r} \qquad \text{Gov. saves on bond payments}$$

and faces permanent exclusion and utility loss ϕ

Recursive Government Problem

- State is $s \equiv (a, b, \zeta)$

  ζ denotes an iid sunspot that coordinates the lenders

- The government chooses to repay or default

$$V(a, b, \zeta) = \max\{V_R(a, b, \zeta), V_D(a)\}$$

Value of Default

$$V_D(a) = \max_{a' \geq 0} \left\{ u(c) - \phi + \beta V_D(a') \right\}$$

subject to

$$c \leq y + a - \frac{a'}{1+r}$$

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- Given $\beta(1+r) = 1$, we have constant consumption

$$V_D(a) = \frac{u(y + (1-\beta)a) - \phi}{1-\beta}$$

Value of Repayment

If investors roll over:

$$V_R^{+}(a,b) = \max_{a' \geq 0, b'} \left\{ u(c) + \beta \mathbb{E} V(a', b', s') \right\}$$

subject to

$$c = y + a - \frac{a'}{1+r} - \kappa b + q(a', b') \left(b' - (1-\delta) b \right)$$

where q reflects default prob:

$$q(a', b') = \frac{1}{1+r} \mathbb{E} \left[\left(1 - d(s') \right) \left(\kappa + (1-\delta) q(a'', b'', s') \right) \right]$$

Value of Repayment

If investors do not roll over:

$$V_R^-(a, b) = \max_{a' \geq 0} \left\{ u(c) + \beta \mathbb{E} V(a', (1-\delta)b, s') \right\}$$

subject to

$$c = y + a - \frac{a'}{1+r} - \kappa b + \quad q(a', b') \left(b' - (1-\delta)b\right) \to 0$$

To pay debt, need to use reserves or cut consumption

Multiplicity of Equilibria

- Coordination failure may lead to self-fulfilling crises (Cole-Kehoe)

- If lenders expect...

  ... repayment, then they rollover, and the govt repays

  ... default, then they don't rollover, and the govt defaults

Characterization

Default thresholds

For a given level of reserves, two thresholds

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$V^D(a) > V_R^+(a, b)$

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$V_R^{-}(a, b) \geq V^D(a)$

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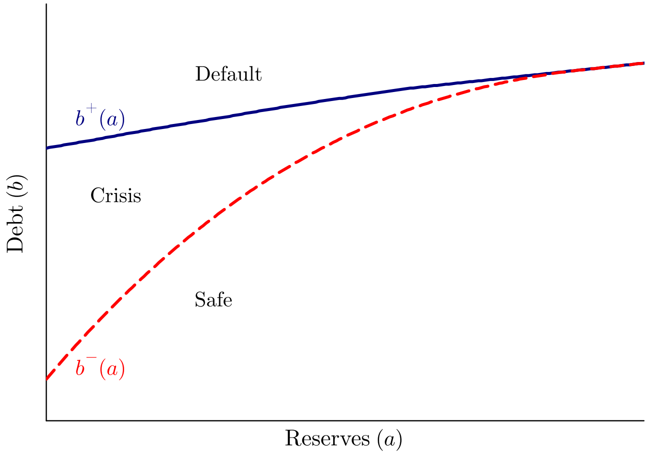
Sunspot: assume government faces a run w/ prob π when initial portfolio (a, b) is in the crisis zone

The Three Zones



Given debt: higher reserves lower vulnerability

More

Escaping the Crisis Zone

How to Exit the Crisis Zone?

Remaining in the crisis zone is risky:

- in case of a run, the govt. faces a costly default

But exiting is also costly:

- requires cutting consumption and improving NFA

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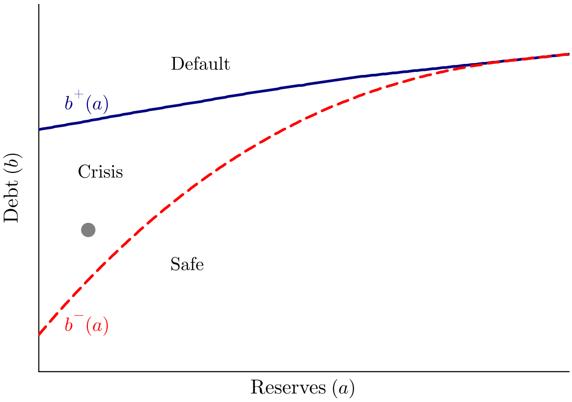
What's the best exit strategy for a country that is in the crisis zone (but didn't face a run today) ?

- Accumulate reserves ($a \uparrow$) or reduce debt ($b \downarrow$)?

Possible Exit Paths



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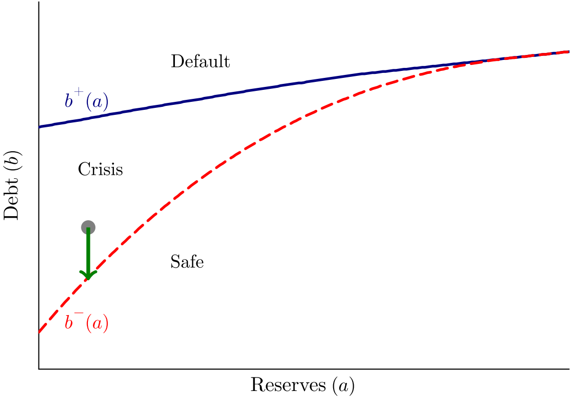

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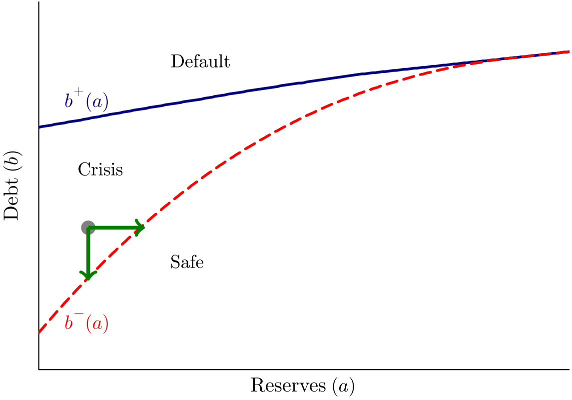

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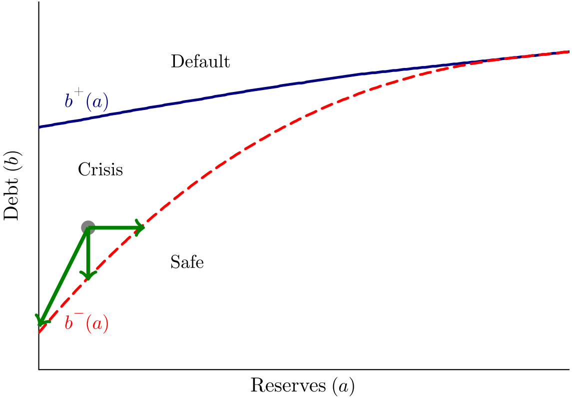

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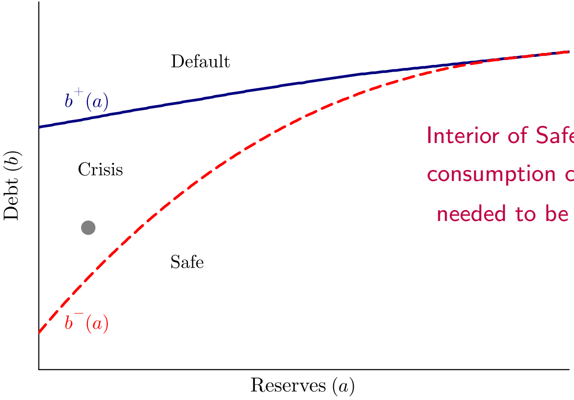
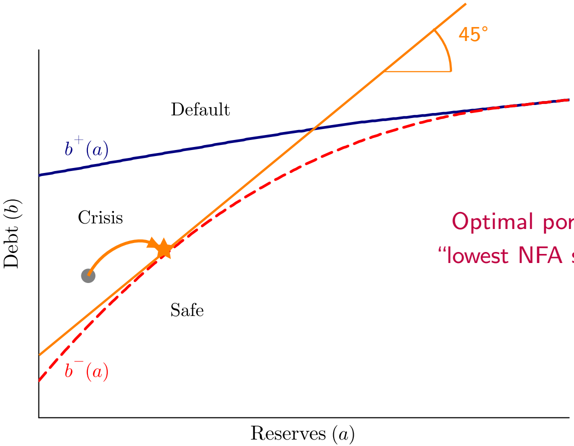


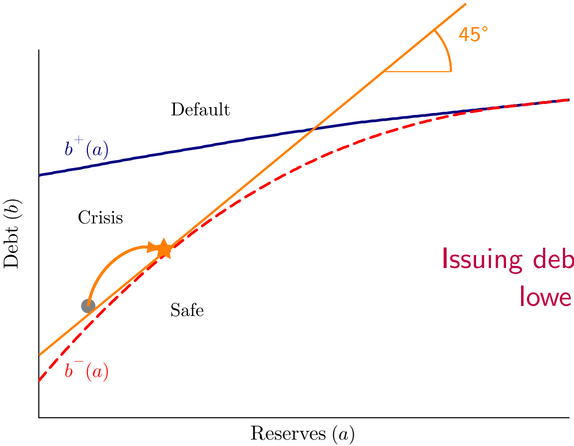
Interior of Safe zone isn't optimal: consumption cut larger than needed to be safe

Optimal Portfolio



Optimal portfolio is the "lowest NFA safe portfolio"

Optimal Portfolio



Issuing debt to buy reserves lowers spreads!

Why do reserves help exit the crisis zone?

Getting to the safe zone requires $V_R^-(a,b) \geq V_D(a)$

- More reserves helps sustain higher gross debt & net debt

  ... even though reserves increase default value $V_D(a)$.

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Intuition

- Only a fraction κ of debt is due every period
- Reserves are liquid and can be used in a run:

$$c = y + \underbrace{a - \kappa b}_{\text{more resources}} - \frac{a'}{1+r}$$

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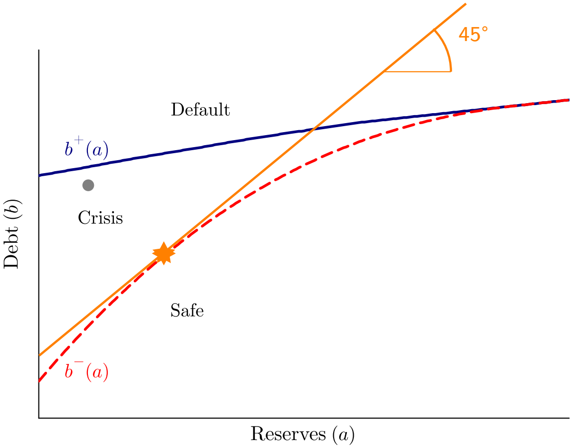

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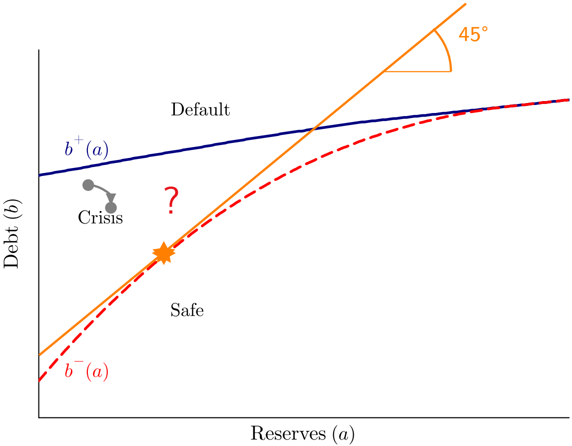

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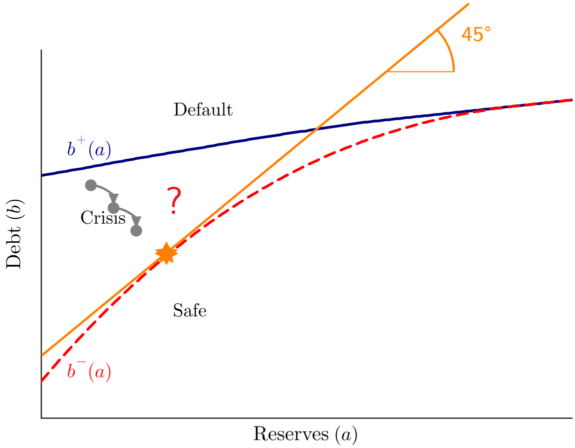

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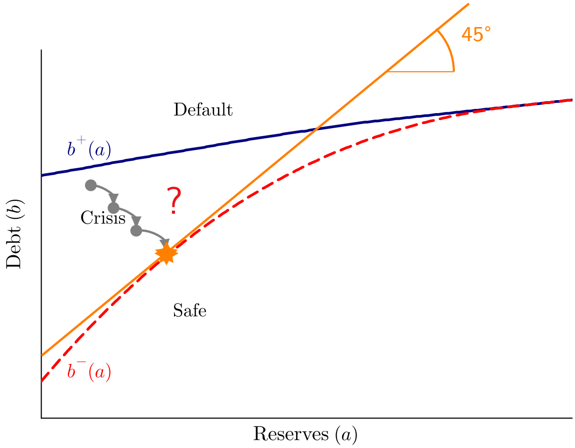

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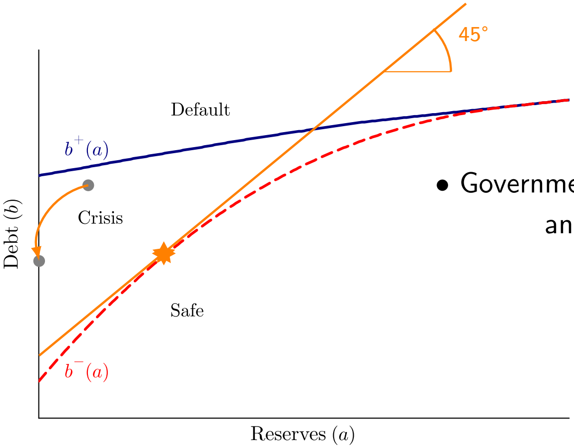

- Government <u>sells</u> reserves and lowers debt

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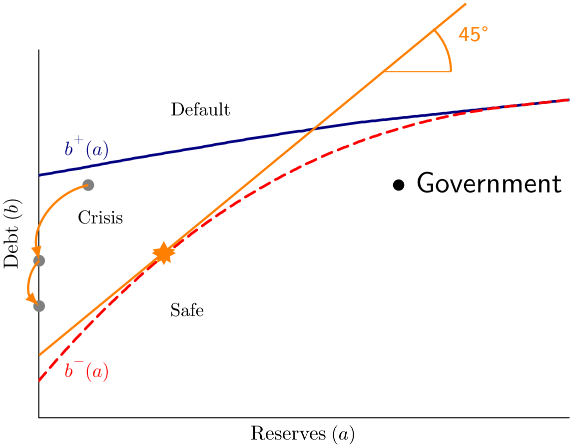
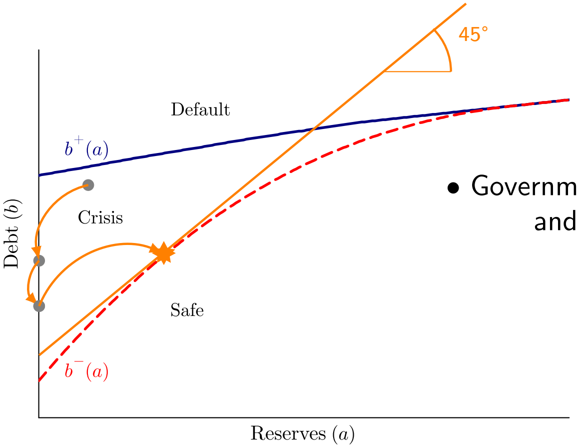


- Government keeps reducing debt

Deep in the Crisis Zone



- Government issues debt and buys reserves

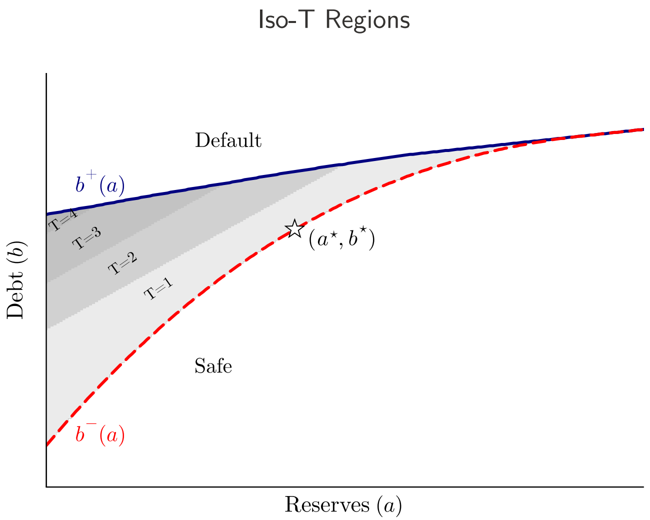
Why selling reserves (initially)?

- When the government is ‘deep’ in the Crisis Zone, on the margin reserves do not change the probability of a run
- Using the reserves to lower debt allows the govt to save on interest payments while deleveraging
- Because consumption is lower under deleveraging than under default, reserves increase consumption dispersion

Deleveraging Dynamics

More

How many periods until exit?



Formalizing the results

When is Lowest-NFA safe portfolio such that $a^\star > 0$

Proposition 3 (Positive reserves)

Suppose that the boundary of the crisis region at zero reserves $b^-(0)$ satisfies

$$\beta(1-\delta)\left[u'\left(y-\kappa b^-(0)\right)-u'\left(y-(1-\beta)(1-\delta)b^-(0)\right)\right] > u'(y)$$

Then, the lowest-NFA safe portfolio has strictly positive reserves, $a^\star > 0$

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- Condition linked to $\left.\frac{\partial b^-(a)}{\partial a}\right|_{a=0} > 1$
- Condition fails when (i) low risk-aversion; (ii) one-period debt $(\delta = 1)$

Formalizing Exit Strategy

Proposition 5 (Optimal portfolio)

Consider an initial portfolio $(a, b) \in \mathbf{C}$. The optimal portfolio satisfies:

- If (a, b) is such that $a - b < a^\star - b^\star$ and $(a', b') \in \mathbf{S}$. Then we have $a' = a^\star$, $b' = b^\star$
- If (a, b) is such that $a - b \geq a^\star - b^\star$. Then, we have $T = 1$ and any portfolio $(a', b') \in \mathbf{S}$ and $a - b = a' - b'$ is optimal.
  If $a = 0, b = b^\star - a^\star$, then $a' = a^\star, b = b^\star$.
- If (a, b) is such that $(a', b') \in \mathbf{C}$. Then, the optimal solution features $a' = 0$.

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