"Whatever it takes" Is All You Need: Monetary Policy and Debt Fragility

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The Magic Wand

"But here is another message I want to tell you. Within our mandates, the ECB is ready to do whatever it takes to preserve the euro.

(pause)

And believe me, it will be enough."

Mario Draghi, July 2012
Global Investment Conference, London

GRAPH

This project

Debt fragility

Self-fulfilling **solvency** debt crisis

↪ Calvo (1988), 2 periods, real economy

↪ A rise in interest rates induces the government to default with a higher probability

↪ Price indeterminacy and multiple equilibria Calvo

Why is Monetary Policy relevant?

Within an optimal taxation program, monetary policy acts via two channels:

- Seignorage revenue from money printing, to complement labor taxes
- Inflation and the real value of nominal debt

⇒ **Can monetary interventions eliminate debt fragility?**

⇒ **If yes, is the strategy credibility?**

Outline

I - Environment

- Private economy
- Fiscal elements of the government
- Monetary interventions

II - Monetary policy and debt fragility

- Strict inflation targeting
- Monetary discretion

III - Monetary backstop to debt fragility

IV - Credibility

Conclusions

Key elements

- Nominal infinite horizon populated by 2-periods OLG

$$E\left[c_o - \frac{n_o^2}{2}\right] - \frac{n_y^2}{2}$$

- Young agents: heterogenous, work and save
  - Heterogenous productivity $y = z_h n$ with $z_h \in \{1 < z\}$
  - Limited asset market participation, cost Γ
  - 'Poor' save with money
  - 'Rich' save with public bonds and real assets (risk free return R)

- Old agents: work and consume
  - Common stochastic productivity $A \sim [A_l, A_h]$ (i.i.d. and full support)
  - Production $y = An$
  - Taxes and consumption

- Government with nominal debt and distortionary taxes
  - Repayment: labor taxes and seignorage from money printing
  - ... or costly default

'Poor' agents - money holder

Mass ν^m with young-age productivity $z^m = 1$

$$\max \; E\left[c_o' - \frac{{n_o'}^2}{2}\right] - \frac{n_y^2}{2}$$

s.t. real budget constraints:

$$n_y = m$$
$$c_o' = A' n_o'(1 - \tau') + m\tilde{\pi}'$$

- m is real money holding
- $\tilde{\pi}$ is the gross inverse inflation rate

⇒ **Labor supply (and money demand)** driven by real return to working

$$n_y^m = m = \tilde{\pi}^e \text{ and } n_o^m = A(1 - \tau)$$

where $\tilde{\pi}^e = E(\tilde{\pi}')$

'Rich' agents

Mass ν^f with young-age productivity $z > 1$

$$\max \; E\left[c_o' - \frac{{n_y'}^2}{2}\right] - \frac{n_y^2}{2}$$

s.t. real budget constraints:

$$\begin{aligned} zn_y &= k + b^f + \Gamma \\ c_o' &= A'n_o'(1-\tau') + Rk + \mathbb{1}_D(1+i')\tilde{\pi}'b^f \end{aligned}$$

with:

- Γ is fixed cost to "participate" in markets (LAMP)
- $D \in \{r, d\}$: $\mathbb{1}_r = 1$ (repay) and $\mathbb{1}_d = 0$ (default)

'Rich' agents - policy functions

Labor supply, driven by real return to working

$$n_y^f = Rz \quad \text{and} \quad n_o^f = A(1-\tau)$$

Saving decision

Indifference between real asset and government bonds:

$$(1+i')\tilde{\pi}^e\big(1-P(d)\big) = R \qquad \textbf{(NAC)}$$

where $P(d)$ is the probability of default.

<u>Note:</u>

- a share θ of public debt is held by domestic agents
- $1-\theta$ by risk neutral deep pocket foreign investors

Elements of fiscal policy

- Every period, flow of real expenses g - (exogenous and constant)
  Financed by nominal debt emission $b = g$

- **Under repayment** - real budget constraint:

$$(1+i)\tilde{\pi} b = \tau\left(\nu^m A n_o^m(\tau) + \nu^f A n_o^f(\tau)\right) + \frac{\Delta M}{P}$$

  (within generations, no debt dynamics)

- Resource from Seignorage

$$\frac{\Delta M}{P} = S(m_{-1}, \sigma, \tilde{\pi}) = \sigma \nu^m m_{-1} \tilde{\pi}$$

  - σ is money printing rate
  - $\nu^m m_{-1}$ is aggregate real money holding of current old

Elements of fiscal policy

- **Under repayment**, using policy functions:

$$\Rightarrow \; (1+i)\tilde{\pi} b = A^2 \tau (1-\tau) + S(m_{-1}, \sigma, \tilde{\pi}) \qquad \textbf{(GBC)}$$

where the real money tax base is endogenous:

$$m_{-1} = n_y^m = E(\tilde{\pi}) = \tilde{\pi}^e$$

- **Default is costly**

- Direct cost to domestic bond holders
- Proportional output loss γ on old agents productivity (<u>contemporaneous</u>)

$\Rightarrow$ **Repayment vs. default is a discrete choice, on old agents only**

Optimal strategic default

Default on debt ($D = d$) iff

$$\Delta(\mathcal{S}) = W^d(.) - W^r(.) \geqslant 0 \qquad \textbf{(OSD)}$$

where

- $W^D(\cdot)$ is welfare of old agents under $D \in \{r, d\}$
- $\mathcal{S}$ contains: - $A \sim [A_l, A_h]$
  - (i, m_{-1}, θ) - predetermined
  - (τ, σ) satisfy **GBC**

For instance, 'rich' agents, aggregate consumption:

$$c_o^f(r) = A^2(1-\tau) + Rk + (1+i)\tilde{\pi}^r\theta b$$
$$c_o^f(d) = A^2(1-\gamma) + Rk + t$$

(t is a lump-sum monetary transfer when the treasury defaults) DETAILS

Finally, some assumptions

Individual saving decisions consistent with young age productivity

$$z^2 > \frac{R\Gamma}{R^2 - 1} > 1 \qquad \textbf{(A.0)}$$

Default is costly: lower bound on γ

$$\frac{A_l^2\gamma(2-\gamma)}{2} > \nu^m \qquad \textbf{(A.1)}$$

Risk-free benchmark: upper bound on level of debt b,

$$b < \frac{A_l^2(1-\gamma)\gamma}{R} \qquad \textbf{(A.2)}$$

so that there is an equilibrium with no default (innocuous)

SREE - Key equations of the game

- Expectations formation on inflation and credit risk: $\Rightarrow (m_{-1}, i)$

$$m_{-1} = \tilde{\pi}^e = \int_A \tilde{\pi}_A dF(A) \qquad \textbf{(MD)}$$

$$(1+i)\tilde{\pi}^e \big(1 - P(d)\big) = R \qquad \textbf{(NAC)}$$

- Nature draws A, central bank sets σ and treasury decides

- repayment

$$(1+i)\tilde{\pi} b = A^2 \tau(1-\tau) + S(m_{-1}, \sigma, \tilde{\pi}) \qquad \textbf{(GBC)}$$

- or default

$$\Delta(\cdot) = W^d(\cdot) - W^r(\cdot) \geq 0 \qquad \textbf{(OSD)}$$

$\Rightarrow$ default threshold $\bar{A}(\mathcal{S})$

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$\Rightarrow$ default threshold $\bar{A}(\mathcal{S})$

$\Rightarrow$ **How does the conduct of σ influence price formation of public security?**

II - Debt fragility in nominal economy

Monetary policy regimes - two benchmark cases

$\Rightarrow$ Is there a SREE where debt valuation depends on *sentiment*?

(1) **Strict inflation targeting**, with commitment

$$\forall \mathcal{S} \; \tilde{\pi}(\mathcal{S}) = \tilde{\pi}^*$$

$\rightarrow$ Given $\tilde{\pi}^*$ and (A, i), the treasury sets taxes or default

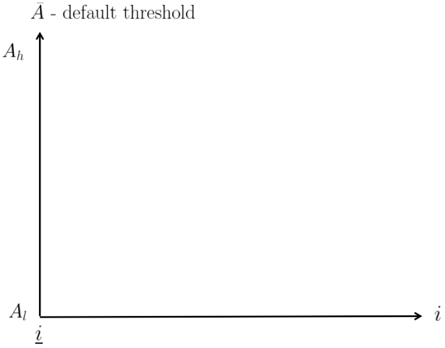
$$(1+i)\tilde{\pi}^* b = A^2(1-\tau)\tau + \nu^m \tilde{\pi}^*(1-\tilde{\pi}^*)$$

$\Rightarrow$ Debt is real de facto, as in Calvo (1988)

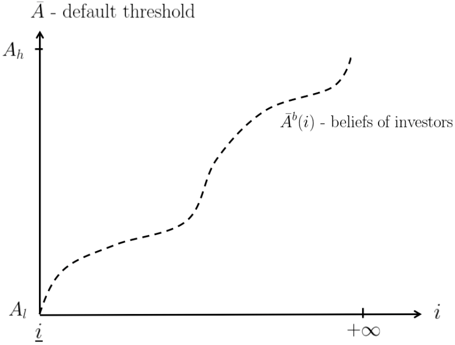
- Interplay between beliefs, interest rate and best-response of government
- Several outcome driven by *sentiment* of agents, welfare ordered

II - Strict inflation targeting

Graphically

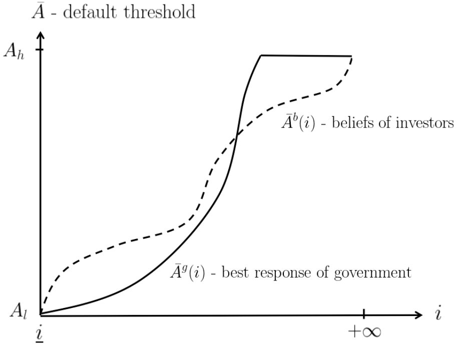


Belief of investors



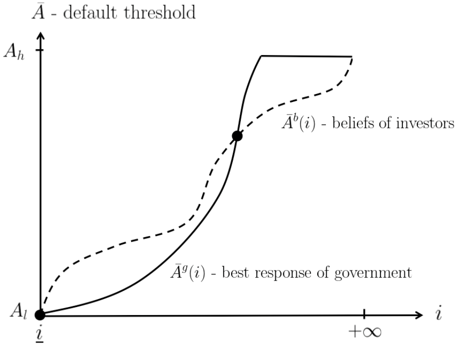
NAC: $(1+i)\tilde{\pi}^*\big(1 - F(\bar{A})\big) = R \Rightarrow \bar{A}^b(i)$

Best response of the government



GBC and **OSD** $\Rightarrow \bar{A}^g(i)$

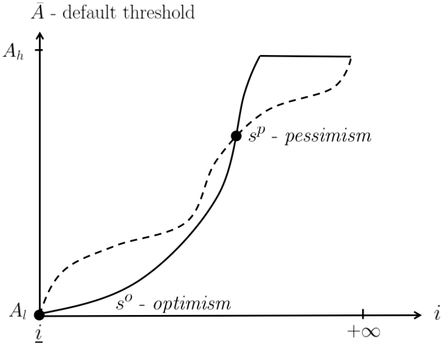
Equilibrium



Equilibrium: $\bar{A}^b(i) = \bar{A}^g(i)$

More

Sunspot coordination device



Sunspot variable $s \in \{s^o, s^p\}$

with p i.i.d. probability of optimism

II - Debt fragility in nominal economy

Monetary policy regimes - two benchmark cases

Is there a SREE where debt valuation depends on *sentiment*?

(2) **Monetary Discretion**:

$$\{\tau, \tilde{\pi}, D\} = \text{argmax } W(\mathcal{S}) \qquad \text{s.t.} \quad \tilde{\pi} \geq \underline{\tilde{\pi}}$$

$\rightarrow$ Fiscal and monetary policy are jointly determined and discretionary

$\Rightarrow$ Inflation expectations?

- Nominal interest rates ... $(1+i)\tilde{\pi}^e(1-F(\bar{A})) = R$
- ... and real money tax base ... $m_{-1} = \tilde{\pi}^e = \int_A \tilde{\pi}_A dF(A)$
- sensitive to expected inflation, $\tilde{\pi}^e$

$\rightarrow$ What do agents expect then?

Government choice under discretion

- Given (A, i, m_{-1}),

$$D \in \{r, d\} = \text{argmax}\Big[\max_{\tau, \sigma^r} W^r(\cdot), \max_{\sigma^d} W^d(\cdot)\Big]$$

subject to:

$$(1+i)\tilde{\pi}^r b = A^2(1-\tau)\tau + S(\underset{+}{m_{-1}}, \underset{+}{\sigma^r}, \tilde{\pi})$$

$$\tau \geq 0 \qquad\qquad \tilde{\pi}^D \geq \underline{\tilde{\pi}}$$

where $\underline{\tilde{\pi}} > 0$ is an 'inflation ceiling' (preserves money)

$\Rightarrow$ **Inflation bias**

More

Equilibrium: debt fragility?

Can central bank adjust money printing and contain pessimism?

Agents anticipate the monetary intervention and the associated high inflation:

- Demand for real money balances decreases: $\downarrow m_{-1}$

$\rightarrow$ Low resource from seignorage

- High inflation priced in nominal debt: $\uparrow i$

$\rightarrow$ No "surprise" inflation

$\Rightarrow$ Joint shift in credit risk and inflation expectations under pessimism

$\Rightarrow$ **The bailout / seignorage channel is ineffective to address self-fulfilling crisis**

III - Monetary backstop to debt fragility

Can monetary interventions address debt fragility?

$\Rightarrow$ Intuition: need to combine

- Anchored inflation expectations
- "Flexibility"

Candidate policy: $\{\tilde{\pi}_A^p\}$

- With commitment (for now)
- Meets the inflation target $\tilde{\pi}^*$
- Distributes inflation and seignorage across $A \sim [A_l, A_h]$
- Deters state contingent default (i.e. contain *pessimism*)

III - Monetary backstop to debt fragility

Desired properties of $\{\tilde{\pi}_A^p\}$

P.1 Anchored inflation expectations

$$\int_A \tilde{\pi}_A^p dF(A) = \tilde{\pi}^*$$

P.2 No 'state-contingent default'

For all i, $\{\tilde{\pi}_A^p\}$ induces the treasury:

- for low i, to repay with probability 1 :

$$\forall\ i < i^\delta \text{ and } \forall\ A,\ \Delta(\cdot) = W^d(\cdot) - W^r(\cdot) < 0$$

- for high i, to default with probability 1 :

$$\forall\ i > i^\delta \text{ and } \forall\ A,\ \Delta(\cdot) > 0$$

⇒ i.e. no possible self-fulfilling solvency crisis

III - Monetary backstop to debt fragility

Existence

- Given $\tilde{\pi}^*$, there is $\{\tilde{\pi}^p_A\}$ that satisfies **P.1** and **P.2**.
- Whenever the monetary authority commits to $\{\tilde{\pi}^p_A\}$, debt is uniquely valued.

Mechanism: "Leaning against the winds"

- Effective for $\nu^m \approx 0$, i.e. inflation channel, not seignorage
- Properties

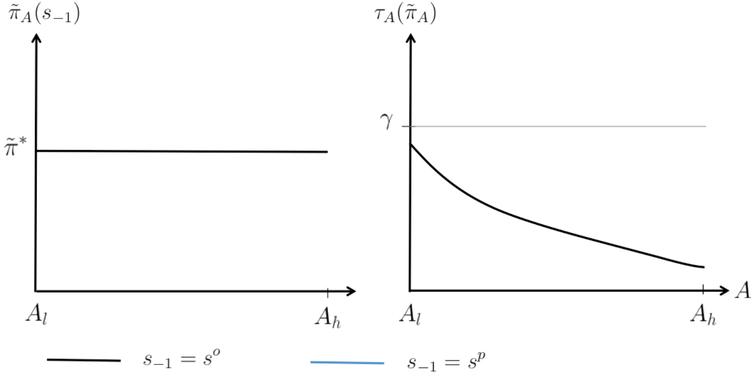
$$\frac{d\tilde{\pi}^p_A}{dA} > 0 \qquad\qquad \tilde{\pi}^p_A > 0$$

- High inflation for low A ... (+ high seignorage revenues),
- ... compensated by low inflation for high A (+ low seignorage revenues)
- to meet the inflation target $\tilde{\pi}^*$

$\Rightarrow$ **Countercyclical monetary policy**

III - Monetary backstop to debt fragility

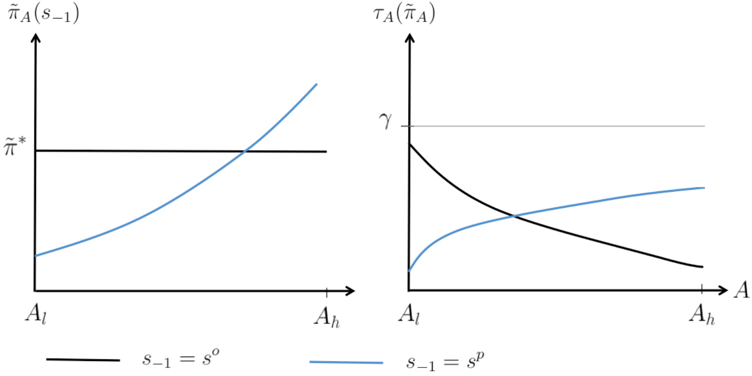
On equilibrium, $s_{-1} = s^o$, strict inflation targeting



$\Rightarrow$ Strict inflation targeting induces procyclical fiscal policy.

III - Monetary backstop to debt fragility

On equilibrium, $s_{-1} = s^p$, "leaning against the winds"



$\Rightarrow$ Countercyclical monetary induces countercyclical fiscal policy.

III - Monetary backstop to debt fragility

Implementability?

So far, conditional on sunspot s_{-1}

$$\tilde{\pi}(A, i, s^o) = \tilde{\pi}^*$$
$$\tilde{\pi}(A, i, s^p) = \tilde{\pi}_A^p$$

Consider a policy conditional on the interest rate i, *... whatever it takes ...*

i. If i satisfies $(1+i)\tilde{\pi}^* = R$, then

$$\forall\ A\ \tilde{\pi}(A, i) = \tilde{\pi}^*$$

ii. If i is such that $(1+i)\tilde{\pi}^* > R$, then

$$\forall\ (A, i)\ \tilde{\pi}(A, i) = \tilde{\pi}_A^p$$

⇒ In equilibrium:
- Unique price of debt: $(1+i)\tilde{\pi}^* = R$
- The central bank implements $\tilde{\pi}^*$ for all A

⇒ **Active / richer commitment is enough to rule out pessimism**

Supporting *'wit'* with reputation

$$\Delta(\cdot) = \underbrace{\left[W^{wit}(A,i,m_{-1}) - W^{dev}(A,i,m_{-1})\right]}_{\text{most profitable deviation}} + \frac{\beta}{1-\beta}\underbrace{\left[V^{wit}(\tilde{\pi}^*) - V^{sit}(\tilde{\pi}^*, p)\right]}_{\text{punishement}}$$

Short term deviation, old agents:

- $W^{wit}(\cdot)$: welfare of implementing *'wit'*

$$\tilde{\pi}(A,i,m_{-1}) = \tilde{\pi}^* \qquad \text{if } i = \underline{i}$$
$$\tilde{\pi}(A,i,m_{-1}) = \tilde{\pi}^p_A \qquad \text{if } i \in [\underline{i}, i^\delta]$$

- $W^{dev}(\cdot)$: most profitable deviation, i.e. monetary discretion

$\Rightarrow$ $W^{wit}(\cdot) - W^{dev}(\cdot) < 0$

Supporting *'wit'* with reputation

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Long run consequences:

- β: generation discount rate
- $V^{wit}(\cdot)$: lifetime expected welfare of a generation under *'wit'*
- $V^{sit}(\cdot)$: return to strict inflation targeting, with risk of debt fragility More

- CB relies on its *institutional spine*, i.e. delivering $\tilde{\pi}^*$ … *within our mandate* …
  - ↪ support *'sit'* with another reputation mechanism
- i.e. evaluate credibility given anchored inflation expectations
  - ↪ otherwise arbitrary expectations, i.e. discretion

⇒ **The lower** p, the higher $V^{wit}(\cdot) - V^{sit}(\cdot) > 0$ … *market stress* …

… **the more credible** to implement *'whatever it takes'* More

Conclusions

Can monetary policy deter self-fulfilling debt crisis?

Focus on monetary strategies of the central bank

- Characterize a solution that:
  - anchors inflation expectations
  - take advantage of ex-post real return of debt rather than seignorage revenue

$\rightarrow$ turn a bond into a state-contingent asset

- Preserve monetary policy mandate

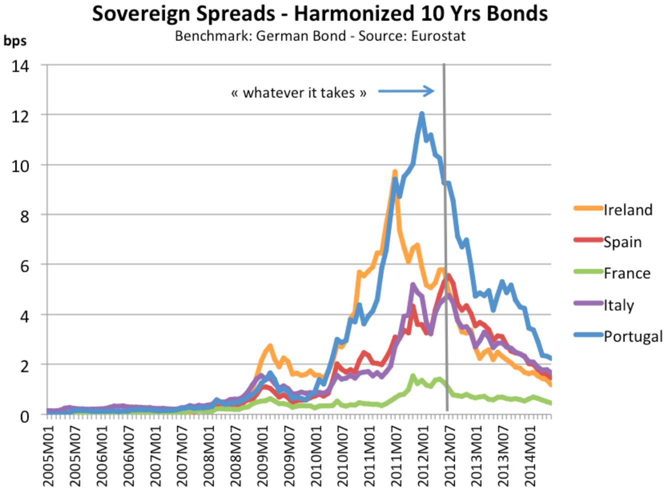
$\rightarrow$ commit "off-equilibrium" to steer expectations along the desired equilibrium path

$\rightarrow$ credible within an inflation-target environment

... *and believe me, it will be enough.*

THANK YOU !

EZ Sovereign Spread



BACK

Formally, a game between investors and the government

Consider a two period economy:

- Today
  - The government issues debt b
  - Investors
    - $\rightarrow$ form beliefs about default $P(d)$
    - $\rightarrow$ and charge an interest rate $(1+i)$

$$(1+i)\big(1-P(d)\big)=R$$

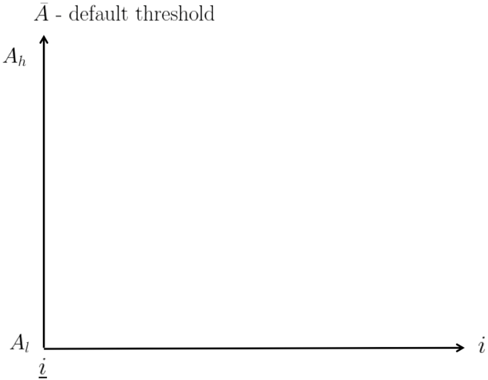
- Tomorrow,
  - given $(1+i)b$ and a realization of "income" $A \sim [A_l, A_h]$
  - government decides:
    - $\rightarrow$ either to raise labor taxes and repay debt: $W^r(A,i)$
    - $\rightarrow$ or to default on debt (costly): $W^d(A,i)$

$$\Delta(\cdot)=W^d(\cdot)-W^r(\cdot)$$

$\Rightarrow$ Default only when the cost of raising taxes is high, i.e. A is low

BACK

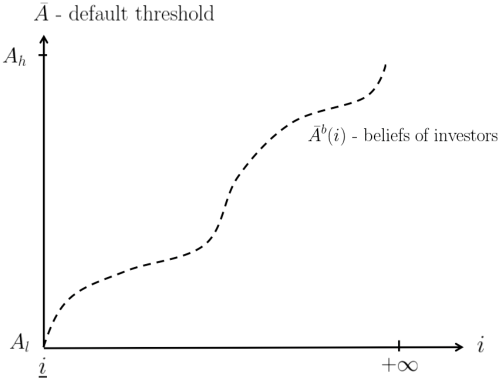
Graphically



BACK

Calvo 1988

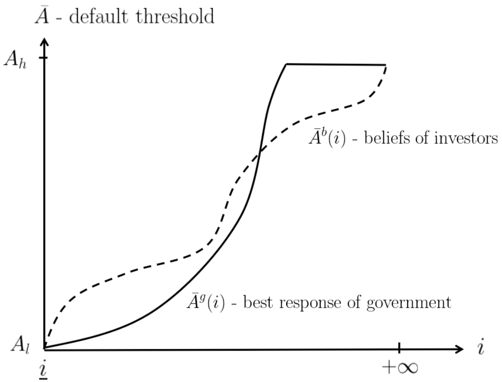
Investors form beliefs about proba of default and charge i



$$(1+i)\big(1-P(d)\big)=R$$

BACK

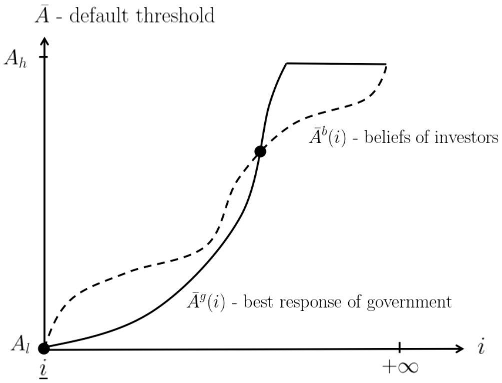
Given i, the government defaults when optimal



$$\Delta(\cdot) = W^d(\cdot) - W^r(\cdot)$$

BACK

In equilibrium, beliefs are “rational”



Interplay beliefs, interest rates and BR of the government

BACK

Optimal Strategic Default - Details

Under repayment:

$$W^r(\cdot) = \frac{\left[A(1-\tau)\right]^2}{2} + \nu^m m_{-1}\tilde{\pi}^r + ((1+i)\tilde{\pi}^r - R)\theta b + \nu^l R(Rz^2 - \Gamma)$$

$$(1+i)\tilde{\pi}^r b = A^2(1-\tau)\tau + S(\sigma, m_{-1}, \tilde{\pi}^r)$$

Under default:

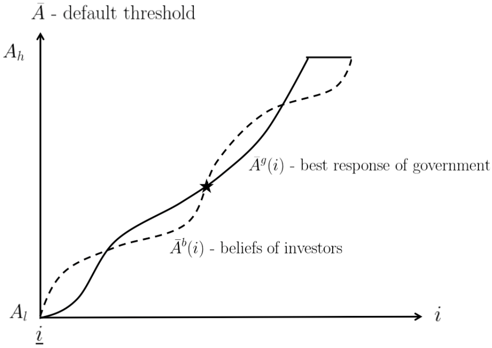
$$W^d(\cdot) = \frac{\left[A(1-\gamma)\right]^2}{2} + \nu^m m_{-1}\tilde{\pi}^d - R\theta b + \nu^l R(Rz^2 - \Gamma) + T(\cdot)$$

$$T(\cdot) = \nu^m m_{-1}(1 - \tilde{\pi}^d)$$

Default iff $\Delta(\cdot) = W^d(\cdot) - W^r(\cdot) \geq 0$

BACK

Role of inflation target?



Equilibrium labelled $\star$ is locally stable under best response dynamics.

BACK

Impact of $\tilde{\pi}^*$?

Proposition 3 - In the equilibrium characterized in Proposition 2, for $\tilde{\pi}^* > \frac{1}{2}$, an increase in the target inflation rate will increase seignorage and lower the probability of default if the equilibrium of the debt financing problem is locally stable under best response dynamics.

Note: An equilibrium of the debt financing problem is locally stable if and only if:

$$\frac{d\bar{A}^g(i)}{di} < \frac{d\bar{A}^b(i)}{di}$$

Graph

BACK

Choice Discretionary Policy Maker (1/3)

Ex-post choice, given (A, i, m):

$$D \in \{r, d\} = \operatorname{argmax}\Big[\max_{\tilde{\pi}^r, \tau} W^r(A, i, m, \tau, \tilde{\pi}^r), W^d(A, i, m, \tau, \tilde{\pi}^d)\Big]$$

subject to:

$$(1 + i)\tilde{\pi}^r b = A^2(1 - \tau)\tau + \nu^m m(1 - \tilde{\pi}^r) \qquad \text{(if } D = r\text{)}$$

$$\tau \geq 0, \quad \tilde{\pi}^r \in [\underline{\tilde{\pi}}, 1]$$

Choice Discretionary Policy Maker (2/3)

Characterization

Under (**A.1**), given (A, i, m), the policy choices of the discretionary government are:

- If the government chooses to repay its debt, then:
  - $\tilde{\pi}^r = \max\left\{\underline{\tilde{\pi}}, \Pi(i,m)\right\}$, where $\Pi(i,m) = \frac{\nu^m m}{(1+i)b+\nu^m m}$
  - $\tau > 0$ and solves (GBC) if and only if $\tilde{\pi}^r = \underline{\tilde{\pi}}$
- If the government chooses to default, then $\tau = 0$ and $\tilde{\pi}^d = \underline{\tilde{\pi}}$
- The government chooses to default if and only if

$$\frac{\left[A(1-\gamma)\right]^2}{2} - \frac{\left[A(1-\tau)\right]^2}{2} + \nu^m m(1-\underline{\tilde{\pi}}) - (1+i)\underline{\tilde{\pi}}\theta b > 0$$

BACK

Equilibrium under discretion (3/3)

Analysis overview

Several steps to characterize the equilibrium

i. Policy choices of a discretionary government

ii. Multiple interest rates and associated inflation expectations

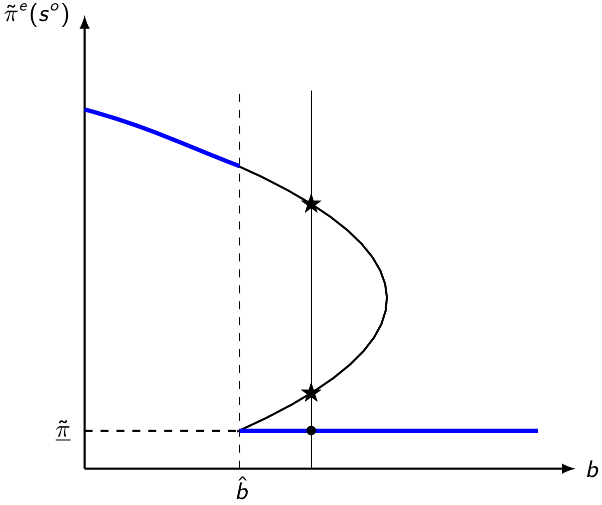
iii. Stationary inflation expectations

Proposition - Sunspot equilibrium

- If $s_{-1} = s^o$, price of debt is consistent with risk-free outcome. $\forall$ A, $\tilde{\pi}(A, \cdot) \geq \underline{\tilde{\pi}}$
- If $s_{-1} = s^p$,
    - price of debt includes a risk premium,
    - inflation expectations are $\tilde{\pi}^e = \underline{\tilde{\pi}}$,
    - the government defaults with positive probability.

BACK

Inflation Expectations, discretion



Multiplicity of Inflation Regime under Optimism

BACK

Lifetime welfare under *Strict Inflation Targeting*

$$
\begin{aligned}
V^{sit}(\tilde{\pi}^*, p) =& p\Big[\int_{A_l}^{A_h} W^r(A, \underline{i}) dF(A)\Big] \\
&+ (1-p)\Big[\int_{A_l}^{\bar{A}} W^d(A, i) dF(A) + \int_{\bar{A}}^{A_h} W^r(A, i) dF(A)\Big] \\
&- \sum_{j \in \{m, l\}} \nu^j \frac{(n_y^j)^2}{2}
\end{aligned}
$$

- As $\tilde{\pi}^e = \tilde{\pi}^*$ under *sit*, $n_y^m = \tilde{\pi}^*$ and $n_y^l = Rz$

$\Rightarrow$ The lower p, the higher *pessimism*, the lower $V^{sit}(\cdot)$

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Deviations considered

$$\Delta(\cdot) = \underbrace{\left[W^{wit}(A,i,m_{-1}) - W^{dev}(A,i,m_{-1})\right]}_{\text{most profitable deviation}} + \frac{\beta}{1-\beta}\underbrace{\left[V^{wit}(\tilde{\pi}^*) - V^{sit}(\tilde{\pi}^*,p)\right]}_{\text{punishement}}$$

Along Eqm path, $i = \underline{i}$ and $\tilde{\pi}(A) = \tilde{\pi}^*$

1) Deviation by the CB

   If $i = \underline{i}$, then CB tempted to implement *discretion*, i.e. *dev*

   Cost is loss of credibility of *wit*

2) Deviation by investors

   If $i > \underline{i}$, then *wit* prescribes $\tilde{\pi}_A^p$ which "invalidates" the initial rise in interest rate

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