Is Inflation Default? The Role of Information in Debt Crises

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Obs 1: Sovereign Debt and Having Your Currency

- Countries that borrow in their own currency more resilient to debt crises
  - High-debt countries: Japan vs. Italy
  - High-deficit countries: UK vs. Spain Plot
- "Domestic"-currency government bond prices react less to bad news

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  $\Longrightarrow$ Interest rates do not jump in anticipation of default

- ...but printing money will cause inflation

  $\Longrightarrow$ Interest rates should jump in anticipation of inflation

Obs 2: Sovereign Spreads vs. Inflation

- Sovereign spreads move very fast, onset of rollover crises is sudden
- Inflation adjusts more slowly (at least in developed economies)

Our Story

- Debt crises require a certain amount of coordination
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- With foreign-currency debt, anticipate spike in default spreads

  $\Longrightarrow$ coordination among **bondholders**
- With domestic-currency debt, anticipate escalation of inflation expectations

  $\Longrightarrow$ coordination among **price setters**

- Price setters less precisely informed about gov't finances

  $\Longrightarrow$ **Information frictions** underlie differential response of bond prices to shocks

Roadmap

- Stylized macro model
- Show it maps into a two-period Bayesian trading game
  - repeated version of Albagli Hellwig Tsyvinski (2015)
- Comparative statics wrt relevant information precision

Setup and Agents

- Three periods: $t = 1, 2, 3$
- Government (described by a mechanical rule)
  - issues debt in $t = 1$
  - repays (or not) in $t = 3$, depending on fiscal shock s

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  - Euro/foreign currency debt: (explicit) default via haircut
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- Consequences of fiscal distress
  - Euro/foreign currency debt: (explicit) default via haircut
  - Yen/domestic currency debt: (implicit) default via inflation
- A continuum of two types of agents: "bond traders" and "workers"
  - risk neutral, unit wealth, cannot short assets, outside option = stay put

Microfoundations

Timing and Actions – First Period

- Government auctions debt at price q_1, promised repayment $\hat{s}(q_1)$; Examples:
  - Eaton and Gersowitz (1981): $\hat{s}(q_1) \equiv \hat{s}$
  - Calvo (1988): $\hat{s}(q_1) \equiv \hat{s}/q_1$
- Bond traders
  - buy bonds conditional on price q_1 (or stay put)
  - info on s: prior $N(\mu_0, 1/\alpha_0)$, private signal $x_{i,1} \sim N(s, 1/\beta_1)$
- Residual noise-traders demand $\Phi(\epsilon_1)$, with $\epsilon_1 \sim N(0, 1/\psi_1)$

Timing and Actions – Second Period

- Bond traders must offload bonds
  - to new bond traders (€), or to workers through cash (¥)
- New bond traders (or workers)
  - buy bonds (cash) conditional on price q_2 (or stay put)
  - info on s: prior $N(\mu_0, 1/\alpha_0)$, private signal $x_{i,2} \sim N(s, 1/\boldsymbol{\beta_2})$
- Residual noise-agents demand $\Phi(\epsilon_2)$, with $\epsilon_2 \sim N(0, 1/\boldsymbol{\psi_2})$

Timing and Actions – Third Period

- If $s \geq \hat{s}(q_1)$, govt repays debt
- If $s < \hat{s}(q_1)$, default (or inflation) $\Rightarrow$ haircut (or currency debasement) $1 - \theta$

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Symmetries and key difference:

- Same eventual default/inflation payoff at the end ($t = 3$)
- Same primary-market participants at the start ($t = 1$)
- Identity of secondary-market ($t = 2$) participants different:
  - bond traders (€) better informed than workers (¥)

$\Rightarrow$ **β_2 (or ψ_2) higher under €**

Three Cases

1. No recall of past prices + exogenous default threshold $\hat{s}$
2. Recall of past prices + exogenous default threshold $\hat{s}$
3. Recall of past prices + endogenous default threshold $\hat{s}(q_1)$

The Simplest Case

Assume

- $\hat{s}(q_1) \equiv \hat{s}$ (constant)
- period-2 agents do not observe q_1

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Period-t agents' information set

- prior
- private signal $x_{i,t}$
- can condition on current-period price $\Rightarrow$ demand schedules $d(x_{i,t}, q_t)$

Period-2 Agents: Payoffs and Strategies

- Expected payoff

$$\underbrace{\theta \cdot \mathrm{Prob}(s < \hat{s}|x_{i,2}, q_2) + 1 \cdot \mathrm{Prob}(s \geq \hat{s}|x_{i,2}, q_2)} - \underbrace{q_2}$$

(€)	$\mathbb{E}_{i,2}$[bond repayment]	bond price
(¥)	$\mathbb{E}_{i,2}\left[1/P_3\right]$	$1/P_2$

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- Posterior beliefs on s are FOSD-increasing in $x_{i,2}$
  - Buy if signal is above threshold:

$$d(x_{i,2}, q_2) = \mathbb{1}[x_{i,2} \geq \hat{x}_2(q_2)]$$

Period-2: Market Clearing and Beliefs

- Period-2 market clearing condition

$$\underbrace{\mathrm{Prob}(x_{i,2} \geq \hat{x}_2(q_2)|s)}_{\text{informed nominal-asset demand}} = \underbrace{1 - \Phi(\epsilon_2)}_{\text{nominal-asset supply (net of noise agents)}}$$

- Market clearing implies

$$s + \frac{\epsilon_2}{\sqrt{\beta_2}} = \hat{x}_2(q_2)$$

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- Market clearing implies

$$z_2 := s + \frac{\epsilon_2}{\sqrt{\beta_2}} = \hat{x}_2(q_2)$$

- We focus on equilibria where z_t is informationally equivalent to q_t
- Second-period agents posterior beliefs

$$s|x_2, z_2 \sim N\left(\frac{\alpha_0\mu_0 + \beta_2 x_2 + \beta_2\psi_2 z_2}{\alpha_0 + \beta_2(1+\psi_2)}, \frac{1}{\alpha_0 + \beta_2(1+\psi_2)}\right)$$

Period-2: Equilibrium

- Marginal agent's indifference condition

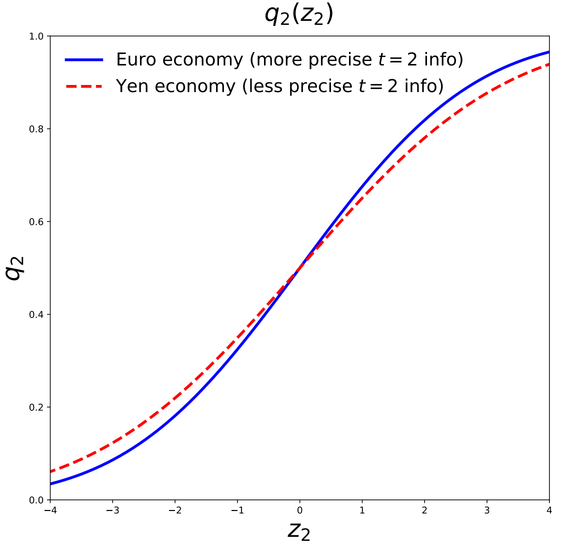
$$\theta + (1-\theta)\mathrm{Prob}(s \geq \hat{s} | x_{i,2} = \hat{x}_2(q_2), q_2) = q_2$$

- Equilibrium $t = 2$ price

$$q_2(z_2) = \theta + (1-\theta)\Phi\left(\frac{(1-w_S)\mu_0 + w_S z_2 - \hat{s}}{\sigma_S}\right)$$

$$w_S := \frac{\beta_2(1+\psi_2)}{\alpha_0+\beta_2(1+\psi_2)}, \qquad \sigma_S^2 := \frac{1}{\alpha_0+\beta_2(1+\psi_2)}$$

Comparative Statics (more precise info = higher β_2 or ψ_2)



Period-1: Strategies and Beliefs

- Expected payoff

$$\mathbb{E}[q_2(z_2)|x_{i,1}, q_1] - q_1$$

- Monotone threshold strategies again

- Market clearing implies

$$z_1 := s + \epsilon_1/\sqrt{\beta_1} = \hat{x}_1(q_1)$$

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$$z_1 := s + \epsilon_1/\sqrt{\beta_1} = \hat{x}_1(q_1)$$

- First-period agents posterior beliefs on z_2, not just s

$$z_2|(z_1, x_1) \sim N\left(\frac{\alpha_0\mu_0 + \beta_1 x_1 + \beta_1\psi_1 z_1}{\gamma_1}, \frac{1}{\gamma_1} + \frac{1}{\psi_2\beta_2}\right)$$

γ_1

Period-1: Equilibrium

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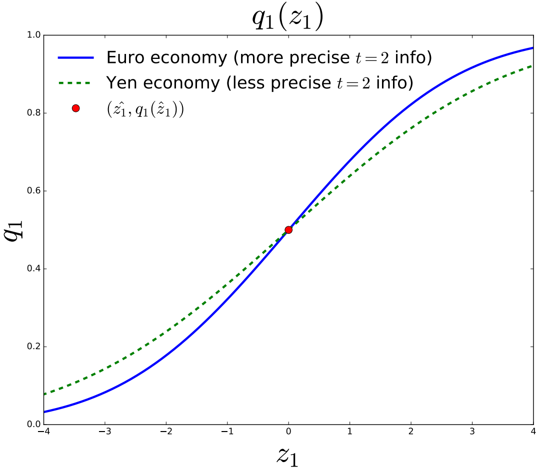
- Equilibrium $t = 1$ price

$$q_1(z_1) = \theta + (1-\theta)\Phi\left[\frac{\mu_0 - \hat{s}}{\sqrt{w_S^2\sigma_{S|B}^2 + \sigma_S^2}} + \frac{w_S w_B}{\sqrt{w_S^2\sigma_{S|B}^2 + \sigma_S^2}}(z_1 - \mu_0)\right]$$

$$w_B := \frac{\beta_1(1+\psi_1)}{\alpha_0+\beta_1(1+\psi_1)}, \qquad \sigma_{S|B}^2 := \frac{1}{\gamma_1} + \frac{1}{\psi_2\beta_2}$$

q_1 with recall

Comparative Statics (more precise info = higher β_2 or ψ_2)



Propositions 1&2

What if there is Recall of the First-Period Price?

- Same payoffs, different information set for period-2 agents
- q_1 new source of common knowledge with period-1 traders
- $q_1 \Longleftrightarrow z_1$
- Marginal period-1 trader and period-2 trader have different weight on z_1; period-2 information is not finer than period 1
- Difference breaks law of iterated expectations:

$$q_1 = E[E[\pi(\theta)|\mathcal{I}_2]|\mathcal{I}_1]$$

- Second-period agents posterior beliefs

$$s|x_2, z_2, z_1 \sim N\left(\frac{\alpha_0\mu_0 + \beta_1\psi_1 z_1 + \beta_2 x_2 + \beta_2\psi_2 z_2}{\alpha_0 + \beta_1\psi_1 + \beta_2(1+\psi_2)}, \sigma_S^2 := \frac{1}{\alpha_0 + \beta_1\psi_1 + \beta_2(1+\psi_2)}\right)$$

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- Equilibrium $t = 1$ price

$$q_1(z_1) = \theta + (1-\theta)\Phi\left[\frac{\mu_0 - \hat{s}}{\sqrt{w_{2,S}^2\sigma_{S|B}^2 + \sigma_S^2}} + \frac{(w_{1,S} + w_{2,S}w_B)}{\sqrt{w_{2,S}^2\sigma_{S|B}^2 + \sigma_S^2}}(z_1 - \hat{s})\right]$$

q_1 w/out recall | $w_{1,S}, w_{2,S}$ | γ_1

Comparative Statics: Some Intuition

$$q_1(z_1) = \theta + (1-\theta)\Phi\left[\frac{\mu_0 - \hat{s}}{S} + K(z_1 - \mu_0)\right]$$

$$K := \frac{(w_{1,S} + w_{2,S} w_B)}{\sqrt{w_{2,S}^2\left(\frac{1}{\gamma_1} + \frac{1}{\beta_2 \psi_2}\right) + \sigma_S^2}}$$

- Always get single crossing, as before
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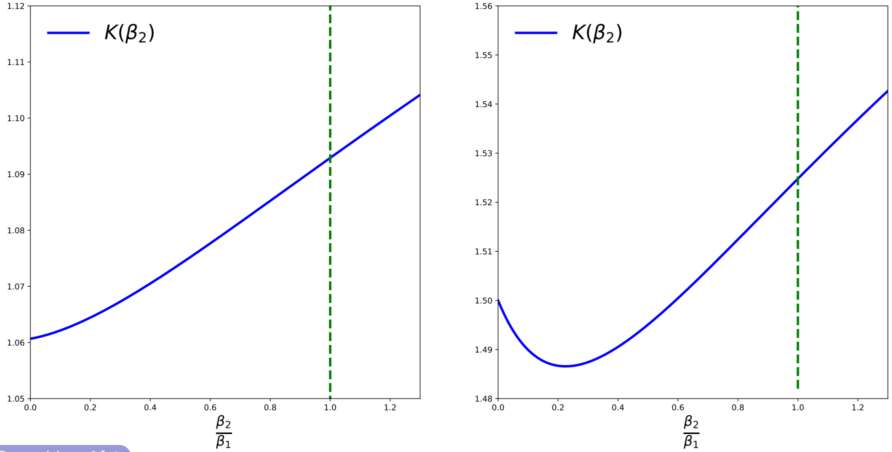
- Effect of β_2, ψ_2 on K more involved:
  - $\beta_2 \uparrow \Longrightarrow$ period-2 agents give less weight to prior, but also to q_1
  - Less weight on prior $\Longrightarrow$ q_2 tracks s better
  - Less weight on $q_1 \Longrightarrow q_2$ tracks s better, but potentially less correlated with q_1, ambiguous

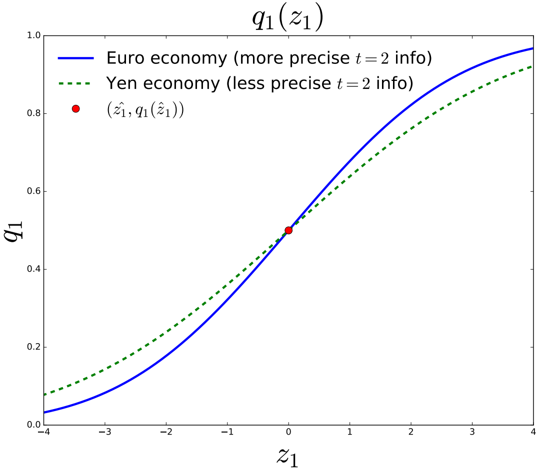
Comparative Statics

$$K := \frac{\left(w_{1,S} + w_{2,S} w_B\right)}{\sqrt{w_{2,S}^2 \sigma_{S|B}^2 + \sigma_S^2}}$$



Propositions 3&4

Single Crossing Again



Endogenous Default Threshold: Equilibrium

- Consider endogenous default cutoff: gov't repays iff $s \geq \hat{s}(q_1)$

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- Period-1 price only implicitly characterized, solves

$$q_1 = \theta + (1-\theta)\Phi\left[\frac{\mu_0 - \hat{s}(q_1)}{\sqrt{w_{2,S}^2 \sigma_{S|B}^2 + \sigma_S^2}} + \frac{(w_{1,S} + w_{2,S} w_B)}{\sqrt{w_{2,S}^2 \sigma_{S|B}^2 + \sigma_S^2}}(z_1 - \mu_0)\right]$$

Endogenous Default Threshold: Comparative Statics

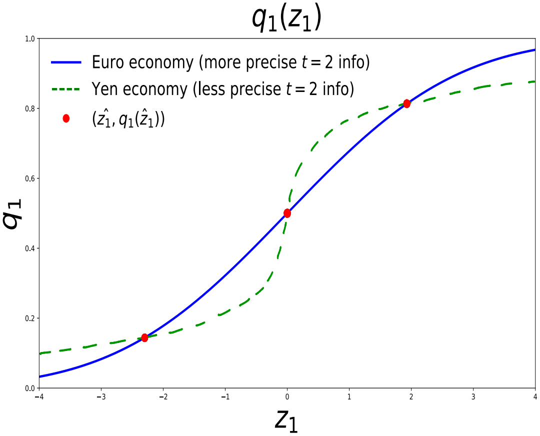
Comparative statics

- on ψ_2: still valid, single crossing

Endogenous Default Threshold: Comparative Statics

Comparative statics

- on ψ_2: still valid, single crossing
- on β_2: price changes are still the same in tail events



Conclusion

- Heterogeneity of information has important implications for debt management
- We have shown insurance role of domestic-currency debt
- Next step: optimal theory of currency denomination (study of effects on ex ante price)

Thank You!

The "Original Sin"

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The “Original Sin”

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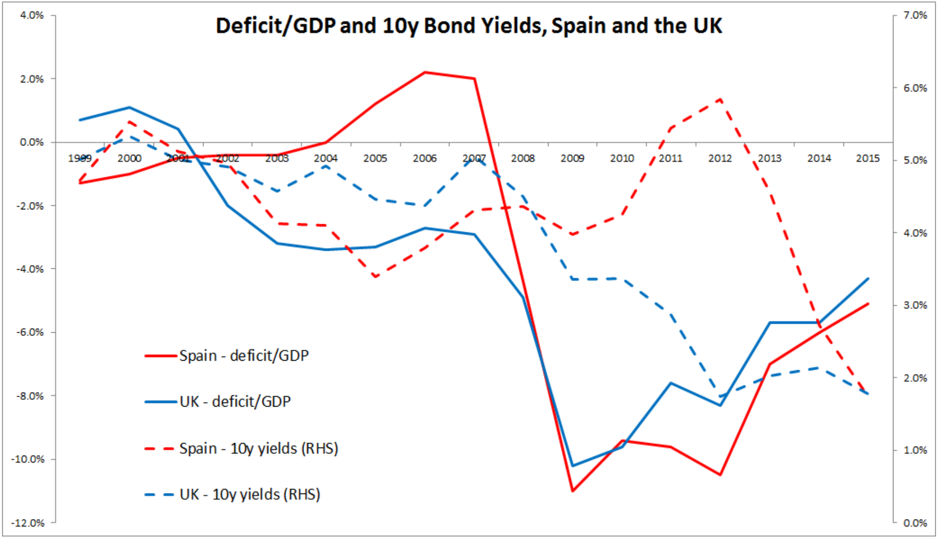
- If this were the problem, we would expect interest rates to be *more* sensitive to bad news with domestic-currency debt
- Bordo-Meissner (2006): Currency mismatch not necessarily associated with more frequent crises
- Ability to devalue and mitigate recession not always relevant (in the 2008 crisis the yen appreciated)


Deficit/GDP and 10y Bond Yields, Spain and the UK
4.0%
2.0%
0.0%
-2.0%
-4.0%
-6.0%
-8.0%
-10.0%
-12.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
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2010
2011
2012
2013
2014
2015
Spain - deficit/GDP
UK - deficit/GDP
Spain - 10y yields (RHS)
UK - 10y yields (RHS)

Back

Macro Model: Setup and actors

- Three periods
- Bond traders: strategic and noise
- Workers: strategic and noise
- Government (described by a mechanical rule)

back to setup

Workers: Preferences and Technology

- Only alive in periods 2 and 3
- Strategic workers
  - One unit of endowment in period 2
  - Wish to consume in period 3, risk neutral
  - Can store good (zero return) or sell it
- Noise workers
  - (Unobserved) relative mass $\Phi(\epsilon_2^w)$, $\epsilon_2^w \sim N(0, 1/\psi_2^w)$
  - Can produce in period 3
  - Demand 1 unit of consumption in period 2

Bond Traders: Preferences and Technology

- 2 OLGs living for two periods
- Endowed with goods when young
- Want to consume when old, risk neutral

- Strategic traders:
  - Can store
  - Can buy one unit of government bonds

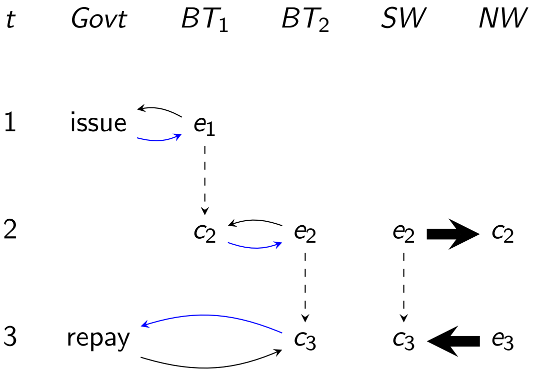
- Noise traders:
  - Demand an (unobserved) fraction $\Phi(\epsilon_t^b)$, $\epsilon_t^b \sim N(0, 1/\psi_t^b)$, of gov't debt

- Mass of bond traders negligible compared to workers

Government - "Euro" scenario

- Auctions one unit of debt in period 1 (per capita per young strategic trader), price q_1
- Debt is a promise to pay $\hat{s}(q_1)$ Euros (goods) in period 3. Examples:
  - $\hat{s}(q_1) \equiv 1$ (Eaton and Gersovitz)
  - $\hat{s}(q_1) \equiv 1/q_1$ (Calvo)
- In period 3, gov't collects taxes, depending on the realization of $s \sim N(\mu_0, 1/\alpha_0)$:
  - If $s \geq \hat{s}(q_1)$, full repayment
  - Otherwise, haircut $1 - \theta$, gov't pays back $\theta \hat{s}(q_1)$

Euro Markets



Price

$$q_1 = \mathbb{E}_{BT_1}[q_2]$$

$$q_2 = \mathbb{E}_{BT_2}[q_3]$$

$$q_3 = \delta\theta + (1-\delta)$$

goods; bonds; storage (dashed)

Yen Markets

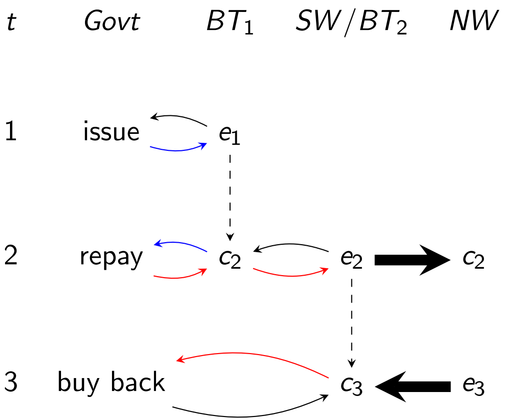
Government - “Yen” scenario

- Auctions one unit of debt in period 1 (per capita per young strategic trader), price q_1
- Debt is a promise to pay $\hat{s}(q_1)$ Yen.
- In period 2, gov't prints Yen, pays debt back.
- In period 3, gov't collects taxes, depending on the realization of $s \sim N(\mu_0, 1/\alpha_0)$:
  - If $s \geq \hat{s}(q_1)$, collects $\hat{s}(q_1)$
  - Otherwise, collects $\theta\hat{s}(q_1)$

  } (same as Euro scenario)
- Period-3 taxes used to buy Yen back. Price level is either 1 or $1/\theta$.

Price Level Determination

Yen Markets



Price

$$q_1 = \mathbb{E}_{BT_1}[\tfrac{1}{P_2}]$$

$$\frac{1}{P_2} = \mathbb{E}_{SW}\left[\frac{1}{P_3}\right]$$

$$\frac{\hat{s}(q_1)}{P_3} = [\delta\theta + (1-\delta)]\hat{s}(q_1)$$

goods; bonds; cash; storage (dashed)

Euro Markets

Euro vs. Yen: the Key Difference

- Eventual default/inflation is the same at the end ($t = 3$)
- Identity of primary-market participants is the same at the start ($t = 1$)

- Period 2 Identity of secondary-market participants different:
  - Under Euro, bonds offloaded to **new bond traders**
  - Under Yen, bonds offloaded to **workers (through cash)**

- With same information, same prices/payoffs in the 2 scenarios:
  - collapse them into a single problem: $q_2 := 1/P_2$ in the Yen case
  - index scenarios with period-2 agents' information precision

Price Level Determination, Yen Economy

Government money valuation equation

$$\frac{M}{P_3} = \text{real tax revenues}$$

and since $M = \hat{s}(q_1)$ (govt repays debt with money at $t = 2$)

$$\frac{M}{P_3} = \frac{\hat{s}(q_1)}{P_3} = \delta \cdot \theta \hat{s}(q_1) + (1 - \delta) \cdot \hat{s}(q_1)$$

so that

$$\begin{cases} \delta = 1 & P_3 = 1/\theta \\ \delta = 0 & P_3 = 1 \end{cases}$$

Back

Equilibrium Definition

Definition

A Perfect Bayesian Equilibrium consists of bidding strategies $d(x_{i,t}, q_t)$ for strategic players, a price function $q(s, \epsilon_t)$ and posterior beliefs $p(x_{i,t}, q_t)$ such that

(i) $d(x_{i,t}, q_t)$ is optimal given beliefs $p(x_{i,t}, q_t)$,

(ii) $q(s, \epsilon_t)$ clears the market for all (s, ϵ_t), and

(iii) $p(x_{i,t}, q_t)$ satisfies Bayes' Law for all market clearing prices q_t.

More Definitions

- Precision of first-period posterior beliefs

$$\frac{1}{\gamma_1} := \frac{1}{\alpha_0 + \beta_1(1+\psi_1)}$$

Case 1: $t = 1$ beliefs Case 1: comparative statics

- Second-period Bayesian weights (case with recall)

$$w_{1,S} := \frac{\beta_1\psi_1}{\alpha_0 + \beta_1\psi_1 + \beta_2(1+\psi_2)} \quad w_{2,S} := \frac{\beta_2(1+\psi_2)}{\alpha_0 + \beta_1\psi_1 + \beta_2(1+\psi_2)}$$

Case 2: q_1

- Aggregate noise term of first-period price (case with recall)

$$S := \sqrt{w_{2,S}^2\left(\frac{1}{\gamma_1} + \frac{1}{\beta_2\psi_2}\right) + \sigma_S^2}$$

Case 2: q_1 Case 2: comparative statics

Simplest Case

Proposition (1)

There exists a cutoff level $\hat{z}_1^{\beta} \in \mathbb{R}$ *such that when* $z_1 < \hat{z}_1^{\beta}$*, a decrease in* β_2 *improves the issuance price* q_1*, whereas the reverse occurs for* $z_1 > \hat{z}_1^{\beta}$*.*

Proposition (2)

There exists a cutoff level $\hat{z}_1^{\psi} \in \mathbb{R}$ *such that when* $z_1 < \hat{z}_1^{\psi}$*, a decrease in* ψ_2 *improves the issuance price* q_1*, whereas the reverse occurs for* $z_1 > \hat{z}_1^{\psi}$*.*

Back

With Recall, Exogenous Threshold

Proposition (3)

There exists a cutoff level $\hat{z}_1^{\psi} \in \mathbb{R}$ *such that when* $z_1 < \hat{z}_1^{\psi}$, *a decrease in* ψ_2 *improves the issuance price* q_1, *whereas the reverse occurs for* $z_1 > \hat{z}_1^{\psi}$.

Proposition (4)

Assume that $\psi_2 \geq \psi_1$ *and* $\beta_2^A \geq \beta_1$. *Let* $\beta_2^B < \beta_2^A$. *Then there exists a cutoff level* $\hat{z}_1^{\beta} \in \mathbb{R}$ *such that when* $z_1 < \hat{z}_1^{\beta}$, q_1 *evaluated at* β_2^A *is smaller than at* β_2^B, *whereas the reverse occurs for* $z_1 > \hat{z}_1^{\beta}$, *holding all other parameters fixed.*

Back

With Recall, Endogenous Threshold

Proposition (5)

Assume that $\psi_2 \geq \psi_1$ and $\beta_2^A \geq \beta_1$, and let the conditions for equilibrium uniqueness hold. Let $\beta_2^B < \beta_2^A$. Then there exist two cutoffs level $\hat{z}_1^L \leq \hat{z}_1^H \in \mathbb{R}$ such that when $z_1 < \hat{z}_1^L$, q_1 evaluated at β_2^A is smaller than at β_2^B, whereas the reverse occurs for $z_1 > \hat{z}_1^H$, holding all other parameters fixed.