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

A Possible Explanation and a Puzzle

- The ability to print money avoids default risk
- $\Longrightarrow$ Interest rates do not jump in anticipation of default
- ... but printing money will cause inflation...
- $\Longrightarrow$ Interest rates should jump in anticipation of inflation

The "Original Sin"

- Some countries seem to be unable to issue domestic debt
- Perhaps because of time-inconsistency (Calvo, 1989)
- 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)

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

- 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

Related Papers on Currency Denomination

Currency denomination of debt

- original sin and time inconsistency: Calvo (1989), Engel and Park (2016)
- crises and currency mismatch: Calvo, Izquierdo, and Talvi (2004), Bordo and Meissner (2006)

Related Papers on Information

- Global games: Morris-Shin (1998)
- Comparative statics with respect to information: Iachan-Nenov (2015)
- Bayesian trading game: Hellwig, Mukherji, Tsyvinski (2006), Albagli, Hellwig, and Tsyvinski (2011), Allen, Morris, and Shin (2006)

Plan of the Talk

- Stylized macro model
- Show that it maps into a two-period Bayesian trading game
- Analyze comparative statics with respect to relevant information precision

Setup and actors

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

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 $\theta \hat{s}(q_1)$

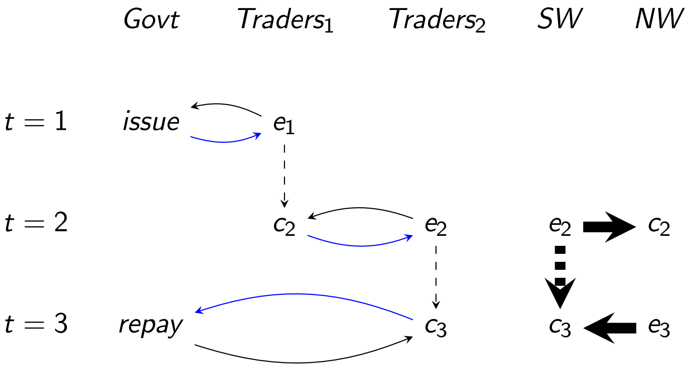
Government - "Yen" scenario

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

$$\left.\begin{array}{l}\text{- If } s \geq \hat{s}(q_1)\text{, collects } \hat{s}(q_1) \\ \text{- Otherwise, collects } \theta\hat{s}(q_1)\end{array}\right\}\text{(same as Euro scenario)}$$

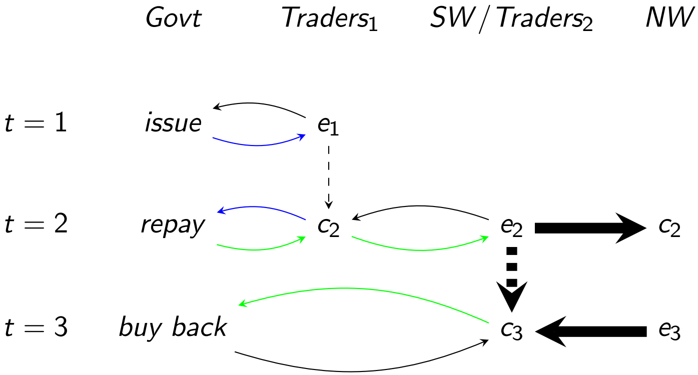
- Period-3 taxes used to buy Yen back. Price level is either 1 or $1/\theta$.

Euro Markets



goods; bonds; storage (dashed)

Yen Markets



goods; bonds; cash; storage (dashed)

Euro vs. Yen: the Key Difference

- Eventual default/inflation is the same at the end, period 3
- Identity of primary-market participants the same at the beginning, period 1
- Period 2 Identity of secondary-market participants different:
  - Under Euro, bonds offloaded to new bond traders
  - Under Yen, offloaded to workers (through cash)

Period 2: Euro vs. Yen

	Euro	Yen
Identity of marginal buyer	bond trader	worker
Goods given up	$\hat{s}(q_1)q_2$	1
Goods received:		
w/o default/inflation:	$\hat{s}(q_1)$	$P_2/P_3 = P_2$
with default/inflation:	$\theta\hat{s}(q_1)$	$P_2/P_3 = \theta P_2$

Collapse the 2 scenarios into a single problem: in the Yen case $q_2 := 1/P_2$

Information

- Strategic traders observe $s + \xi^b_{i,t}$, with $\xi^b_{i,t} \sim N(0, 1/\beta^b_t)$
- Strategic workers observe $s + \xi^w_{i,2}$, with $\xi^w_{i,2} \sim N(0, 1/\beta^w_2)$
- Comparative statics with respect to:
  - β^w_2 vs. β^b_2 signal precision
  - ψ^w_2 vs. ψ^b_2 (inverse of) confusion from noise traders

Three Cases

1. No recall of past prices + exogenous default threshold $\hat{s}$
2. Perfect recall of past prices + exogenous default threshold $\hat{s}$
3. Perfect 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

Period-t agents' information set

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

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.

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

- 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

$$z_2 := s + \frac{\epsilon_2 \psi_2}{\sqrt{\beta_2}} = \hat{x}_2(q_2)$$

- 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

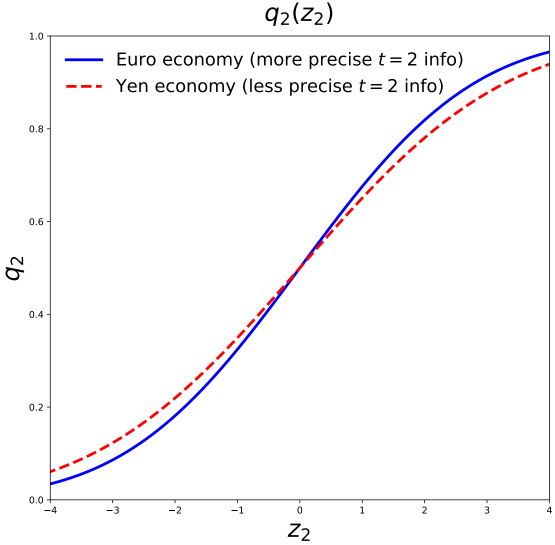
$$\theta + (1-\theta)\mathrm{Prob}(s \geq \hat{s} | x_{i,2} = \hat{x}_2(q_2), q_2) = q_2$$

- 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

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

  - q_2 is increasing in z_2
  - posterior beliefs are FOSD-increasing in $x_{i,1}$
- Monotone threshold strategies again Demand schedules still monotone: $d(x_{i,1}, q_1) = \mathbb{1}[x_{i,1} \geq \hat{x}_1(q_1)]$
- Market clearing implies

$$z_1 := s + \epsilon_1 / \sqrt{\beta_1 \psi_1} = \hat{x}_1(q_1)$$

  - again, z_1 observationally equivalent to 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

- Marginal traders' indifference condition

$$\mathbb{E}[q_2(z_2)|x_{i,1} = \hat{x}_1(q_1), q_1] = q_1$$

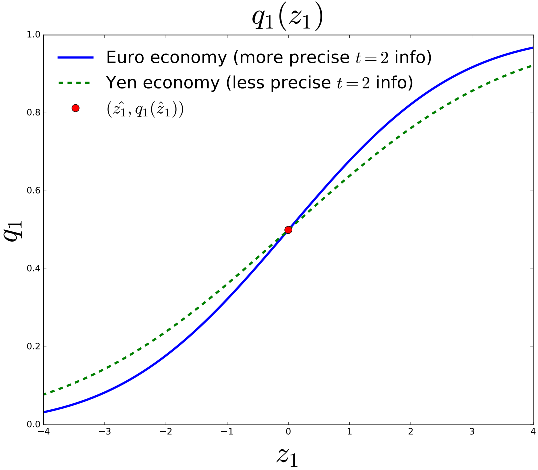
- Equilibrium $t = 1$ price

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

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

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

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

- 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

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

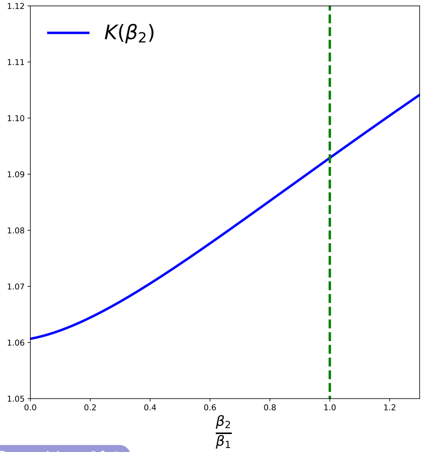
$$K := \frac{(w_{1,S} + w_{2,S} w_B)}{\sqrt{w_{2,S}^2\left(\frac{1}{\gamma_1} + \frac{1}{\beta_2\psi_2}\right) + \sigma_S^2}}$$

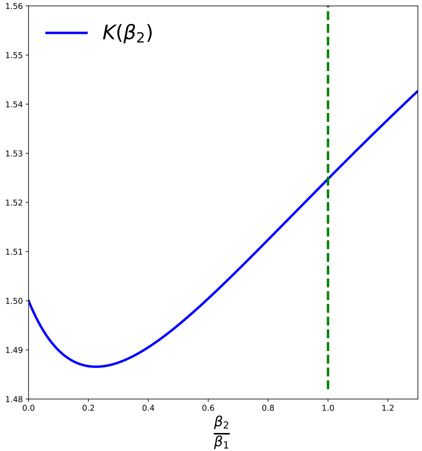
- Always get single crossing, as before
- Direction of crossing dictated by K

- 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

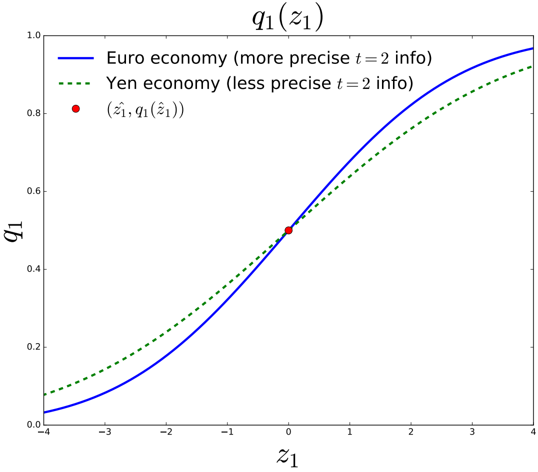
$$K := \frac{\left(w_{1,S} + w_{2,S}\, w_B\right)}{\sqrt{w_{2,S}^2 \sigma_{S|B}^2 + \sigma_S^2}}$$





Propositions 3&4

Single Crossing Again



Endogenous Default Threshold: Equilibrium

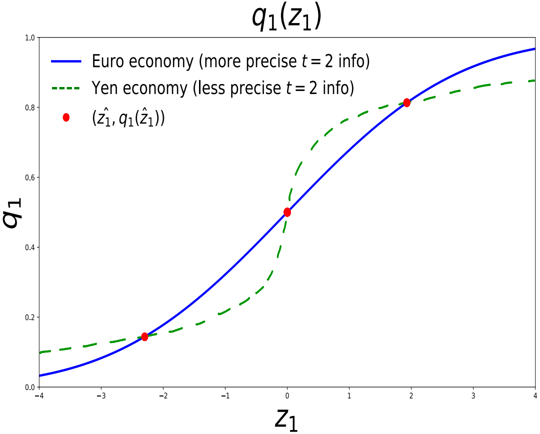
- Consider endogenous default cutoff: gov't repays iff $s \geq \hat{s}(q_1)$
- Period-1 price only implicitly characterized, solves

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

Endogenous Default Threshold: Comparative Statics

Comparative statics

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



Back to Original Sin

- So far, analysis from the perspective of country with good prior
- With bad prior, more informative price may be an advantage
  - $\Longrightarrow$ reason to issue debt in foreign currency
- Alternative rationale for original sin

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!

Precision of first-period posterior beliefs

- Precision of first-period posterior beliefs

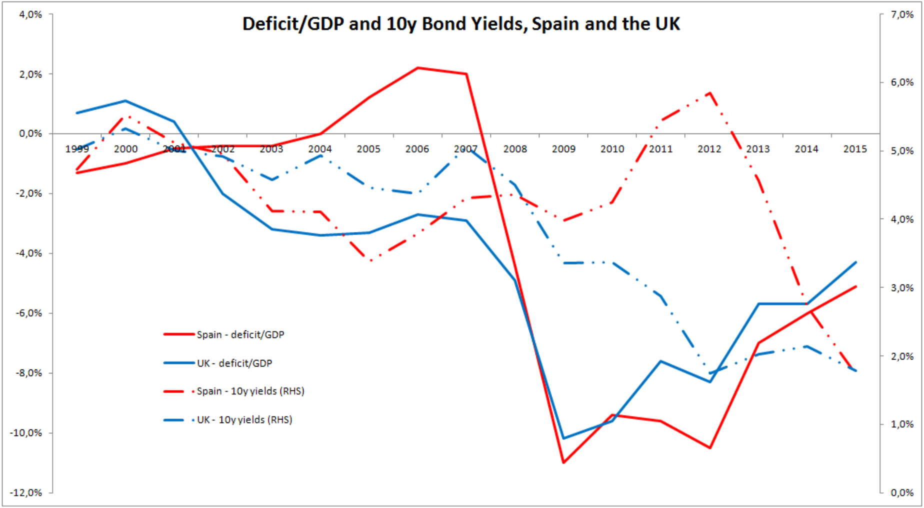
$$\frac{1}{\gamma_1} := \frac{1}{\alpha_0 + \beta_1(1+\psi_1)}$$

Case 1: beliefs   Case 1: comp stat

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

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

Back


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%
0,0%
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Spain - deficit/GDP
UK - deficit/GDP
Spain - 10y yields (RHS)
UK - 10y yields (RHS)

Back