Liquidity, Default Risk, and the Information Sensitivity of Sovereign Debt

Stelios Fourakis

University of Minnesota

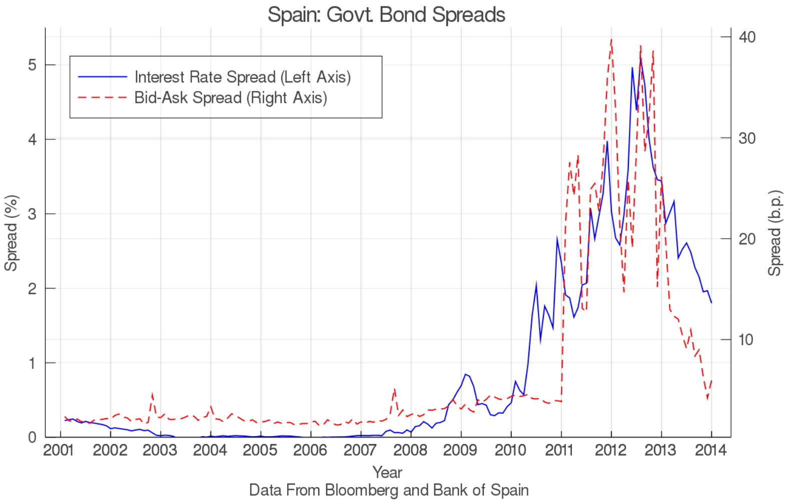
foura001@umn.edu

June 5, 2020

This Paper

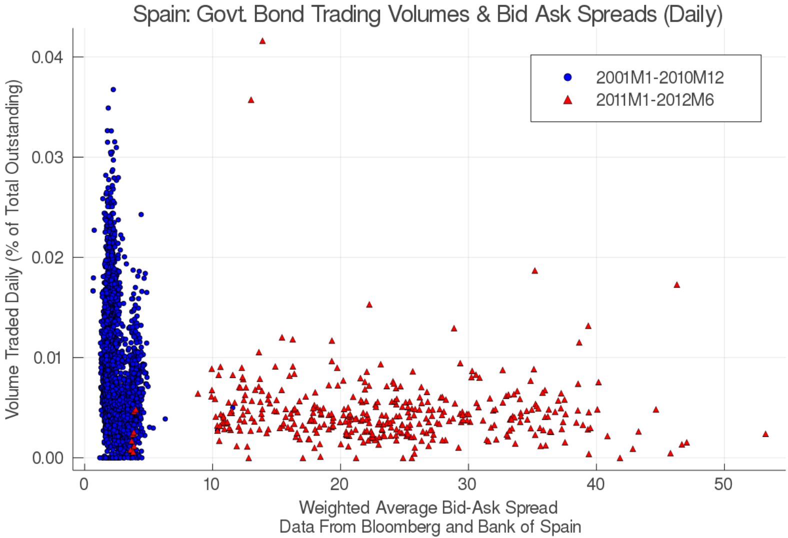
- Document empirical relationships between interest rate spreads, liquidity, and default risk in Spain.
  - Bid-Ask Spread $= Y\bar{T}M_{Bid} - Y\bar{T}M_{ASK}$
- Explain variation in liquidity measures as the equilibrium result of some traders having private information.
- Match business cycle patterns of debt accumulation in a developed country using more flexible preferences.

Bid-Ask Spreads and Interest Rates: Spain



▸ vs. CDS S ▸ Bid-Ask Spread Time Series ▸ Interest Rate Spread Time Series

Liquidity and Bid-Ask Spreads: Spain



▸ Monthly Data

Literature Review

- Passadore and Xu (2018) and Chaumont (2018):
  - This paper has no search frictions in secondary markets.
  - Differences in valuations not driven by permanent changes in investor preferences (good investor vs. bad investor).
- Gorton and Ordonez (2014 and 2019) and Dang, Gorton, and Holmstrom (2015):
  - This paper implements a version of their "information sensitivity" concept.

Key Ingredients

- Model of external sovereign debt a la Eaton Gersovitz (1981).
- Add model of secondary market interactions with:
  1. Ability of some agents to acquire private, payoff-relevant information
  2. Anonymous trading
  3. Random differences in fundamental valuations of bonds between buyers and sellers

Environment

- Small open economy.
- Output is a Markov Process $y(s)$.
- Benevolent government and representative consumer. Recursive preferences.
- Single long term bond: maturity rate λ & coupon rate κ
- While in default, output is reduced.
- Continuum $[0, \bar{B}]$ of risk neutral, competitive international investors, each of whom can hold a unit of debt.
- Current investors may spend $f(\pi)$ to access information about $y(s')$ one period ahead of time with probability π.

Timing

1. Income and reentry realized.
2. Default decisions.
3. Primary market opens, borrowing decisions made, auction occurs.

Timing

1. Income and reentry realized.
2. Default decisions.
3. Primary market opens, borrowing decisions made, auction occurs.
4. A noisy signal $\hat{y}'$ about GDP in the next period becomes available. Current investors may attempt to access it at cost.
5. Current investors' random taste shocks are realized.

Timing

1. Income and reentry realized.
2. Default decisions.
3. Primary market opens, borrowing decisions made, auction occurs.
4. A noisy signal $\hat{y}'$ about GDP in the next period becomes available. Current investors may attempt to access it at cost.
5. Current investors' random taste shocks are realized.
6. Secondary market opens:
   - Random matching.
   - Bid and ask prices submitted simultaneously.
   - If $p_{bid} \geq p_{ask}$, the transaction clears at p_{bid}.
   - New purchasers replace exiting sellers.

Government Problem

$$W(s,b) = max_{d\in\{0,1\}}(1-d)W^R(s,b) + dW^D(s) \tag{1}$$

Conditional on repayment:

$$W^R(s,b) = max_{c,b'},U(c,\bar{W}(s,b')) \tag{2}$$

such that

$$c + (\lambda + (1-\lambda)\kappa)b = y(s) + q(s,b')(b' - (1-\lambda)b) \tag{3}$$

Conditional on default:

$$W^D(s) = U(y(s) - \phi(s), \bar{W}^D(s)) \tag{4}$$

where $\mu(.)$ is a certainty equivalent operator and:

$$\bar{W}(s,b') = \mu(W(s',b')|s) \qquad \bar{W}^D(s) = \mu(W(s',0), W^D(s')|s) \tag{5}$$

Secondary Markets

- Risk neutrality and competitiveness of lenders:

$$q(s, b') = \max_{\pi}(1 - \pi)q_U(s, b') + \pi q_I(s, b') - f(\pi) \tag{6}$$

- $\pi_S(s, b')$ = equilibrium proportion of current investors who obtain access to $\hat{y}'$.
- $q_U(.), q_I(.)$ = value of being uninformed or informed, respectively.
- $\pi_S(s, b') \in (0, 1)$ implies:

$$q_I(s, b') - f'(\pi) = q_U(s, b') \tag{7}$$

Secondary Markets - Notation

- v denotes the undiscounted unit value of the asset to an uninformed agent.

$$v(s, b') = E[(1 - d(s', b'))(\lambda + (1 - \lambda)(\kappa + q(s', b''(s', b'))))|s] \quad (8)$$

Secondary Markets - Notation

- v denotes the undiscounted unit value of the asset to an uninformed agent.

$$v(s, b') = E[(1 - d(s', b'))(\lambda + (1 - \lambda)(\kappa + q(s', b''(s', b'))))|s] \quad (8)$$

- $\hat{v} \sim G(.)$ denotes the random variable which is the undiscounted unit value of the asset to an informed agent (and of course $E[\hat{v}] = v$).

$$\hat{v}(s, \hat{y}', b') = E[(1 - d(s', b'))(\lambda + (1 - \lambda)(\kappa + q(s', b''(s', b'))))|s, \hat{y}'] \quad (9)$$

Secondary Markets - Notation

- v denotes the undiscounted unit value of the asset to an uninformed agent.

$$v(s, b') = E[(1 - d(s', b'))(\lambda + (1 - \lambda)(\kappa + q(s', b''(s', b'))))|s] \quad (8)$$

- $\hat{v} \sim G(.)$ denotes the random variable which is the undiscounted unit value of the asset to an informed agent (and of course $E[\hat{v}] = v$).

$$\hat{v}(s, \hat{y}', b') = E[(1 - d(s', b'))(\lambda + (1 - \lambda)(\kappa + q(s', b''(s', b'))))|s, \hat{y}'] \quad (9)$$

- $\hat{\delta} \sim F(.)$ denotes the random taste shock of current investors.
- δ denotes the constant, known taste shock of new investors.

Secondary Markets - Sellers

Given any bid strategy of buyers and their own $\hat{\delta}$, sellers solve:

$$q_U(v|\hat{\delta}) = max_{p_{S,U}} \mathbf{1}\{p_{S,U} > p_B\}\hat{\delta}v + \mathbf{1}\{p_{S,U} \leq p_B\}p_B \tag{10}$$

or:

$$q_I(\hat{v}|\hat{\delta}) = max_{p_{S,I}} \mathbf{1}\{p_{S,I} > p_B\}\hat{\delta}\hat{v} + \mathbf{1}\{p_{S,I} \leq p_B\}p_B \tag{11}$$

Secondary Markets - Sellers

Given any bid strategy of buyers and their own $\hat{\delta}$, sellers solve:

$$q_U(v|\hat{\delta}) = max_{p_{S,U}} \mathbf{1}\{p_{S,U} > p_B\}\hat{\delta}v + \mathbf{1}\{p_{S,U} \leq p_B\}p_B \tag{10}$$

or:

$$q_I(\hat{v}|\hat{\delta}) = max_{p_{S,I}} \mathbf{1}\{p_{S,I} > p_B\}\hat{\delta}\hat{v} + \mathbf{1}\{p_{S,I} \leq p_B\}p_B \tag{11}$$

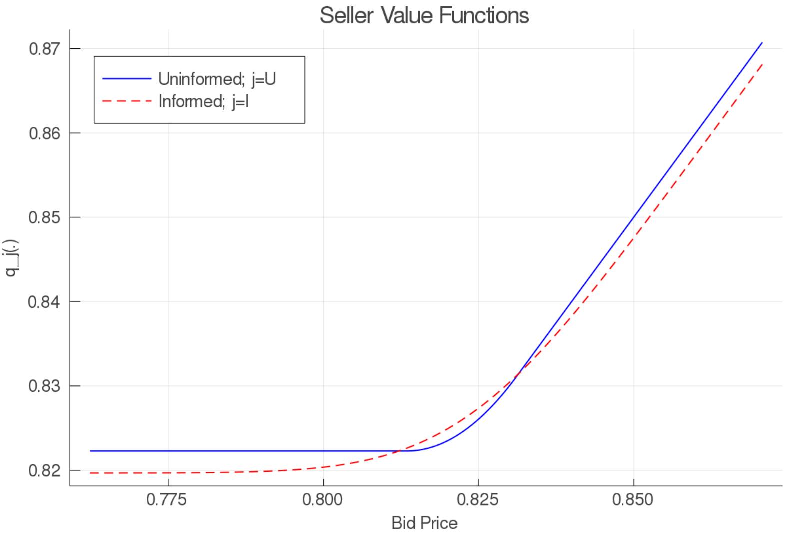
Since transactions clear at the bid price:

$$p^\star_{S,U}(\hat{\delta}, v) = \hat{\delta}v \qquad\qquad p^\star_{S,I}(\hat{\delta}, \hat{v}) = \hat{\delta}\hat{v} \tag{12}$$

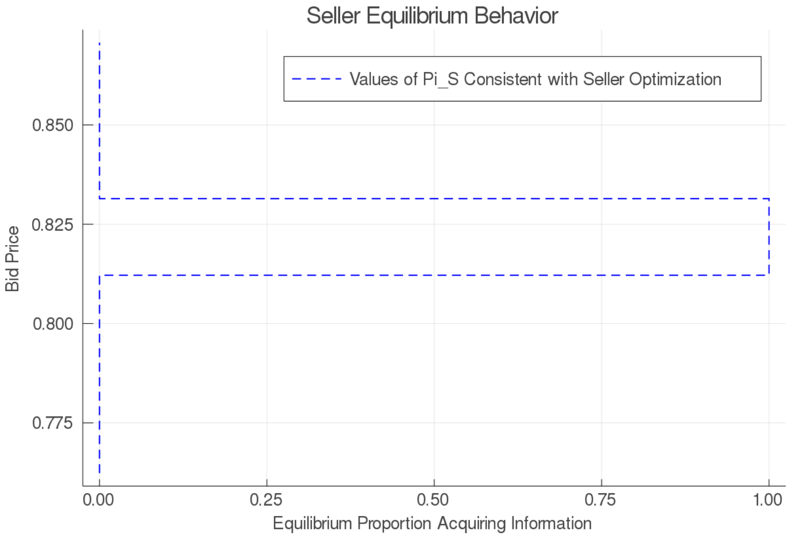
Probabilities of trading at a given bid price p_B:

$$Pr(Trade|U, v)(p_B) = F(\frac{p_B}{v}) \qquad Pr(Trade|I, \hat{v})(p_B) = F(\frac{p_B}{\hat{v}}) \tag{13}$$

Secondary Markets - Seller Values



Secondary Markets - Seller Equilibrium Behavior



Secondary Markets - Buyers

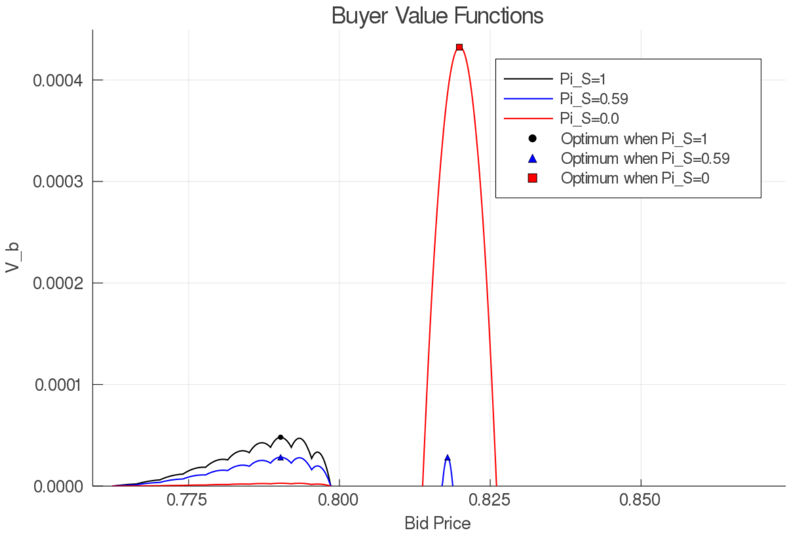
- Buyers then solve:

$$max_{p_B}(1-\pi_S)(\delta v - p_B)F(\frac{p_B}{v})$$
$$+\pi_S\left(-Pr(\hat{v}=0)p_B + \int_V (\delta\hat{v} - p_B)F(\frac{p_B}{\hat{v}})dG(\hat{v})\right) \tag{14}$$

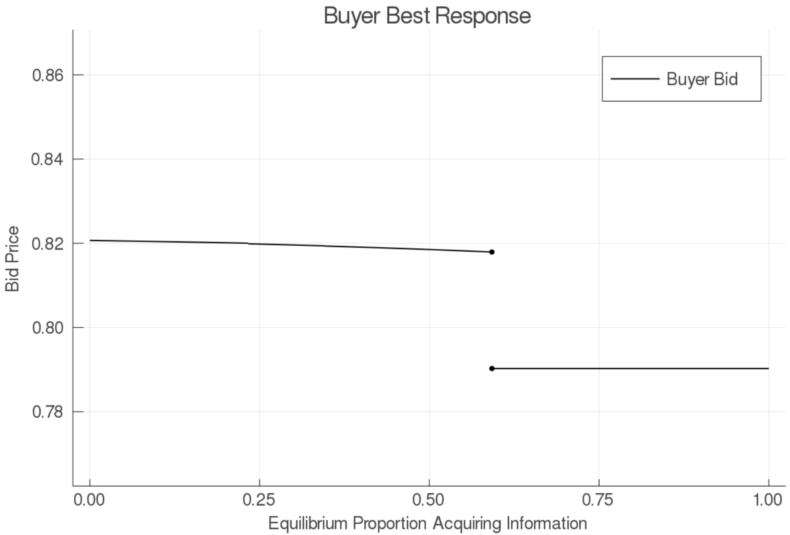
- Mechanism driving bid ask spreads:

  $(\delta\hat{v} - p_B)$ negatively correlated with $F(\frac{p_B}{\hat{v}})$

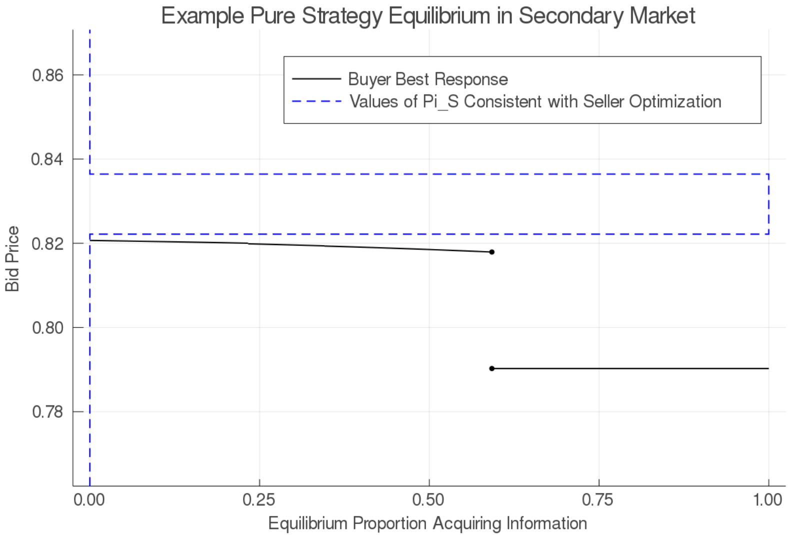
Secondary Markets - Buyer Values



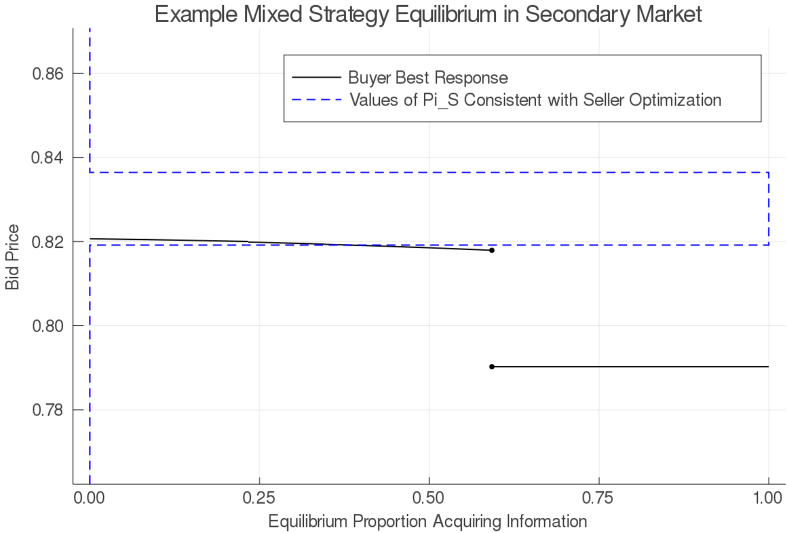
Secondary Markets - Buyer Best Response



Secondary Markets - Equilibrium



Secondary Markets - Equilibrium



▸ Eqm. With Both Mixing

Functional Forms

- Epstein-Zin Preferences:

$$U(c, \bar{W}'(s)) = ((1-\beta)c^{1-\psi} + \beta \bar{W}'(s)^{1-\psi})^{\frac{1}{1-\psi}} \tag{15}$$

$$\bar{W}'(s) = E[W(s')^{1-\gamma}|s]^{\frac{1}{1-\gamma}} \tag{16}$$

- $y(s) = \tilde{y} + m$

$$\tilde{y}' = \rho\tilde{y} + \eta \qquad \eta \sim^{iid} N(0, \sigma_\eta^2) \qquad m \sim^{iid} TN(0, \sigma_m^2, -\bar{m}, \bar{m}) \tag{17}$$

- $\hat{\delta} \sim U(\underline{\delta}, \bar{\delta})$
- $\hat{y}'$ parametrized as the true $\tilde{y}'$ plus a noise term:

$$\hat{y}' = \tilde{y}' + \epsilon \qquad\qquad \epsilon \sim^{iid} N(0, \sigma_\epsilon^2) \tag{18}$$

Calibration

All parameter values are monthly, where applicable.

Table 1: Fixed Parameters

Parameter	**Value**	**Notes**
ρ	0.9918	SE: 0.007
σ_η	0.0049	SE: 0.0005
σ_m	0.0015	SE: 0.0004
$\bar{m}$	0.0031	
θ	0.0130	CE 2012
$\underline{\delta}$	0.990	Fix implied $r_f = 0.33\%$ when $\pi_S = 0$
δ	0.999	Fix B-A Spread $= 2.5$ b.p. when $\pi_S = 0$
$\bar{\delta}$	1.001	Fix volumes$=37\%$ when $\pi_S = 0$
λ	0.0122	Weighted Average Maturity of Debt
κ	0.0041	Average Coupon of Debt

Calibration

This leaves the parameters below.

Table 2: Calibrated Parameters

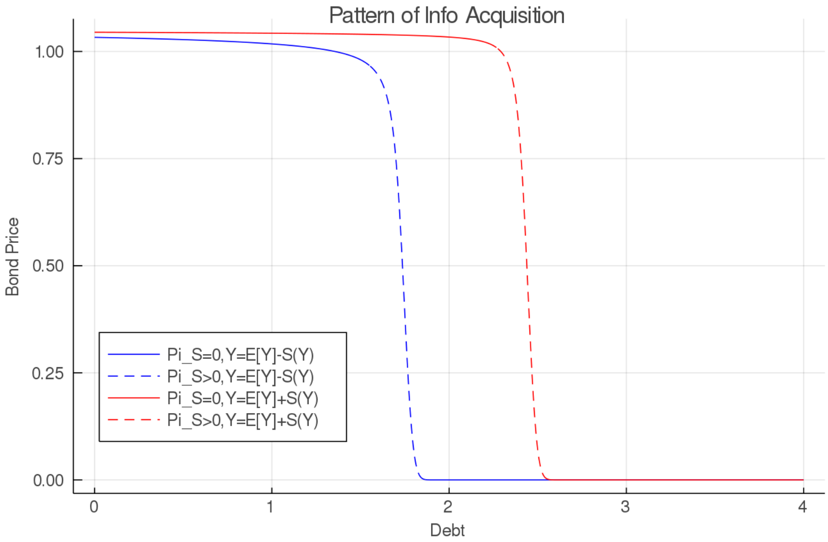
Parameter	**Value**	**Notes**
ψ	11.73	Govt Inverse IES
γ	4.83	Govt Risk Aversion
β	0.992	Govt Discount Factor
d_0	-0.110	Linear Default Cost
d_1	0.142	Quadratic Default Cost
f	0.000125	Cost of Information (Linear)
σ_ϵ	0.037	SD of Noise in $\hat{y}$

Results

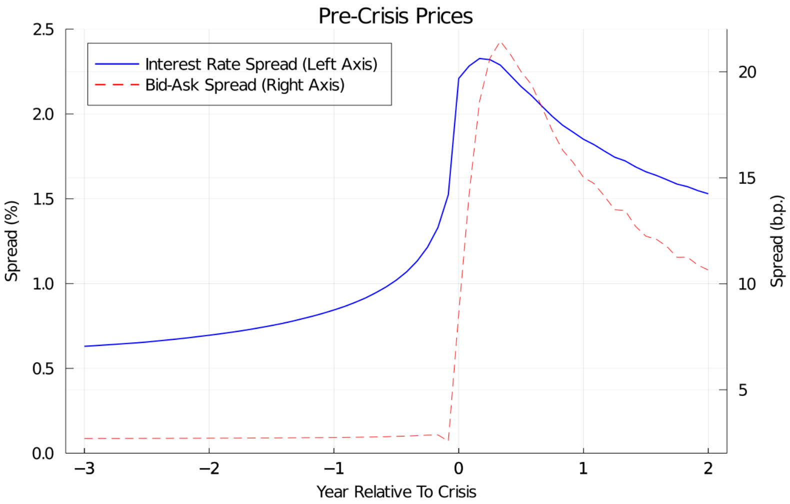
Table 3: Targeted Moments (Annualized Values)

Moment	**Period**	**Data**	**Model**
$E[B'/Y]$	Jan 1 2001 - June 30 2012	11.9%	13.5%
$\rho(B'/Y, ln(Y))$	Jan 1 2001 - June 30 2012	-0.76	-0.49
$\rho(NX/Y, ln(Y))$	Jan 1 2001 - June 30 2012	-0.78	-0.10
$E[r - r^f]$	Jan 1 2001 - June 30 2012	0.72%	0.83%
$\sigma(r - r^f)$	Jan 1 2001 - June 30 2012	1.13%	1.05%
$E[BA]$	Jan 1 2001 - June 30 2012	5.5 b.p.	5.4 b.p.
$\rho(BA, r - r^f)$	Jan 1 2001 - June 30 2012	0.84	0.80

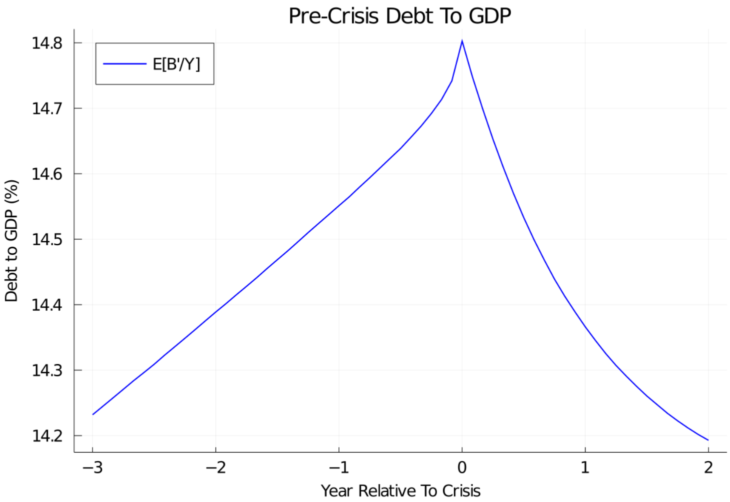
Results - Mechanism



Results - Crises



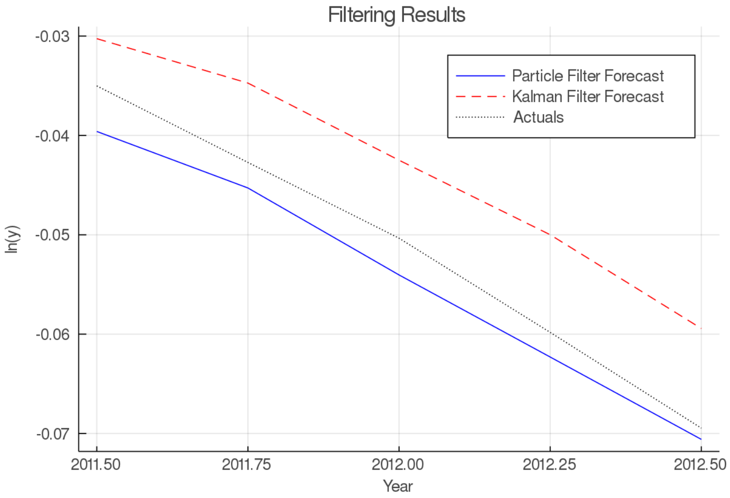
Results - Crises



Results - Validation

- In the model, realized bid-ask spreads depend on the distribution of forecasts obtained by investors.
- Those forecasts in turn depend on the true value of future output.
- Therefore, bid-ask spreads should provide information on future output.
- Does including this information improve forecasts of Spanish output during the crisis relative to the one-step ahead prediction of the Kalman Filter?

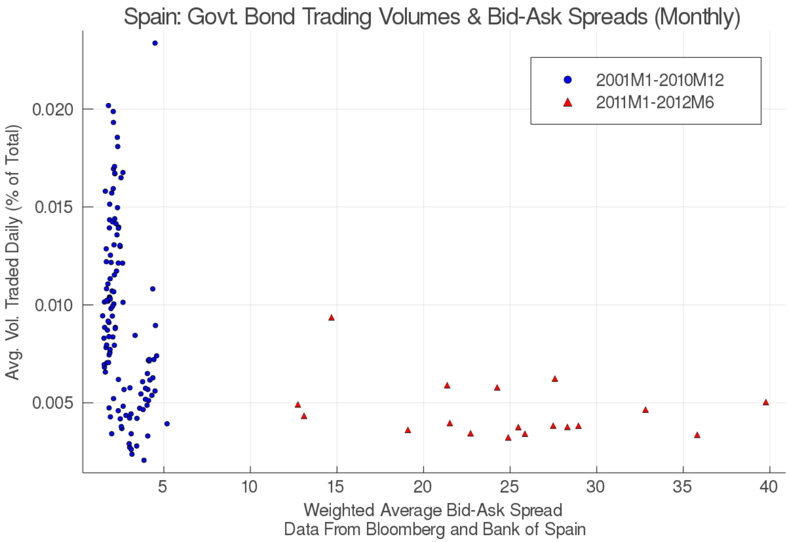
Results - Validation



Conclusions

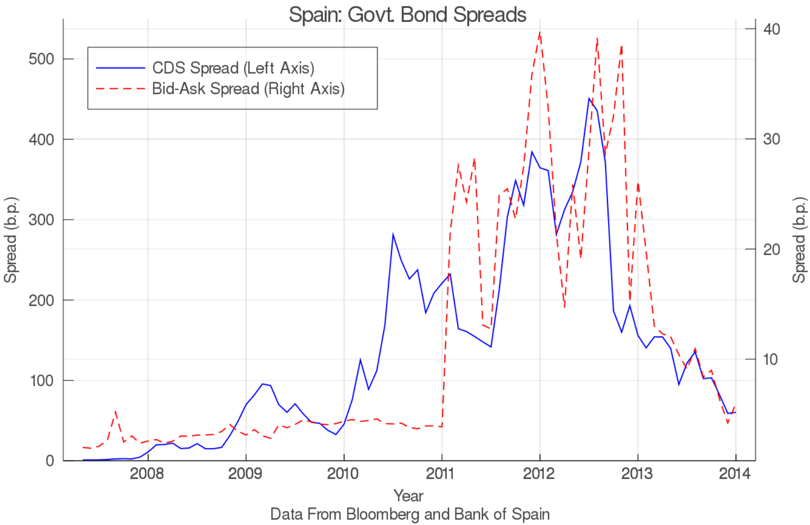
- A model of costly acquisition of private information by traders can rationalize the type of relationship between bid-ask spreads and interest rate spreads/default risk observed in the data.
- Predictions the model makes about the relationship between bid-ask spreads and future realizations of output are borne out in the data.

Liquidity and Bid-Ask Spreads: Spain



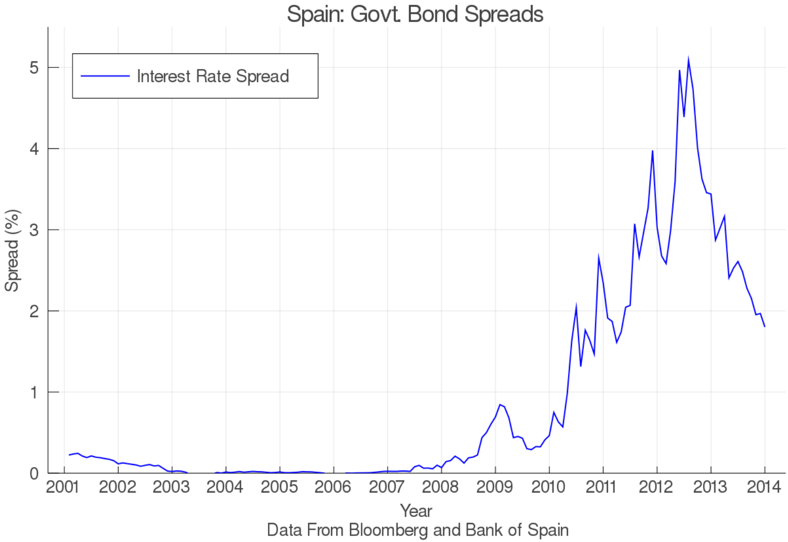
Back

Bid-Ask Spreads and CDS Spreads: Spain



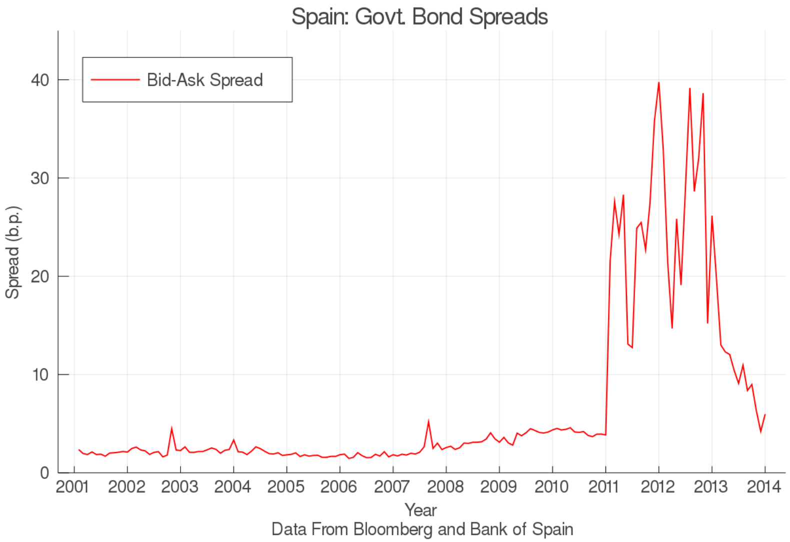
Back

Interest Rates: Spain



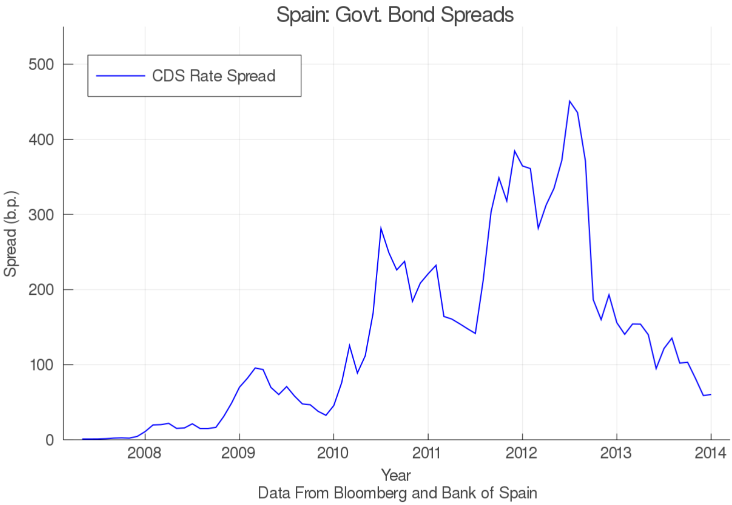
Back

Bid-Ask Spreads: Spain



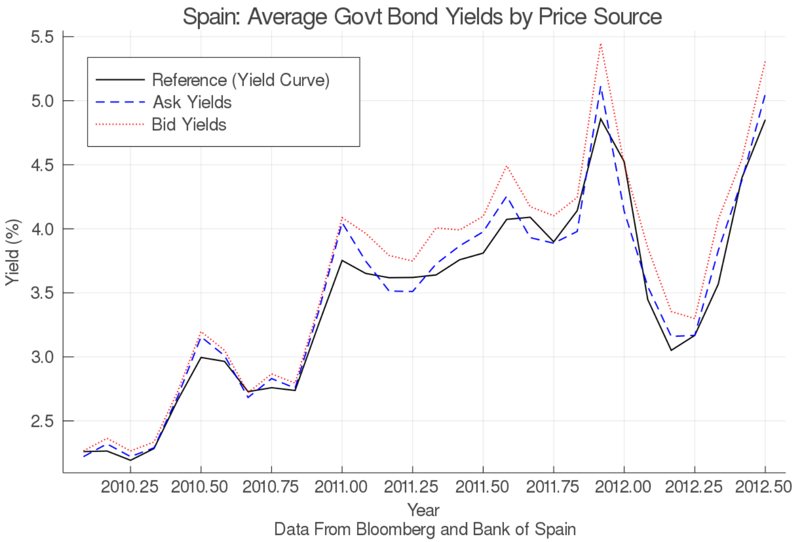
◂ Back to Int/BA ◂ Back to CDS/BA

CDS Spreads: Spain



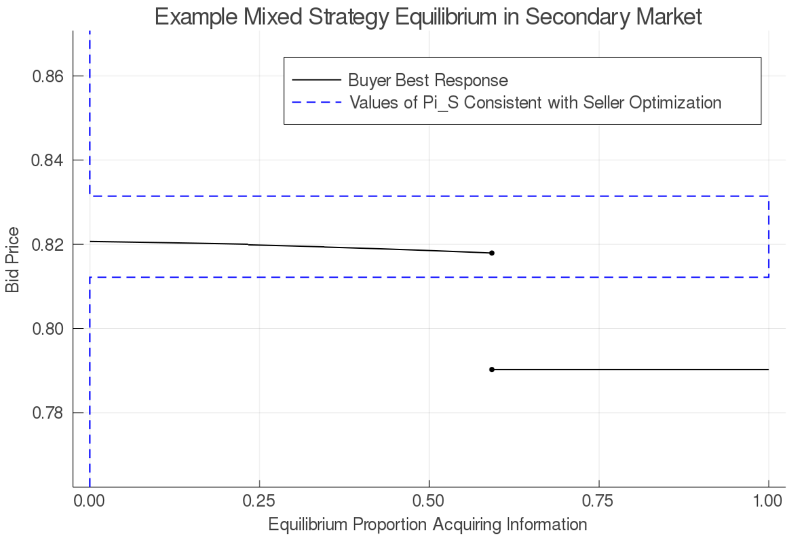
Back

Bid-Ask Spreads: Spain



◂ Back

Secondary Markets - Equilibrium



Back