Information Spillovers and Sovereign Debt: Theory Meets the Eurozone Crisis

Harold Cole, Daniel Neuhann, and Guillermo Ordoñez

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Background

- Sovereign bonds are typically sold in sequences of auctions.
- The most commonly used protocol is the discriminatory-price protocol.
- Milton Friedman in 1959: a bad idea because of the winner's curse.
  - Discourages participation and lowers prices.
- The U.S. followed Friedman's advice. Many other countries did not.

- What are the consequences of this choice?
  - Previous work: asymmetric information in Mexican bond auctions.
  - Found this to be *costly* for gov't: substantially higher average yields.
  - But also *beneficial* during crises: lower yields than otherwise.

- Today: information choice and spillovers (externalities on other countries).

Motivating Questions and Results

1. Discriminatory protocol offers rents to those informed about bond values.
   - **When is information acquired?**

     $\Rightarrow$ When very exposed to the bond and/or fundamentals are expected bad.

     $\Rightarrow$ Strategic complementarity and multiplicity.

2. Global investors can choose in which countries to invest.
   - **How information choices affect capital flows?**

     $\Rightarrow$ Flows out of turbulent countries and into "ignorance" havens.

If a country suffers a negative shock: Get informed or get out?

$\Rightarrow$ Segmentation and spillovers of information regimes across countries.

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   $\Rightarrow$ Segmentation and spillovers of information regimes across countries.

3. Government bonds can also be traded in secondary markets.
   - **How does this affect information choices?**

     $\Rightarrow$ Secondary markets raise value of information.

Application: Eurozone Sovereign Debt Crisis

- Key European countries use discriminatory auctions (e.g. GER, POR, ITA).

- 2010-2011 Eurozone crisis produced a number of striking facts:
  1. Yields first co-moved, then decoupled.
  2. Yields first stable, then volatile only in some countries.
  3. Markets first well integrated, then segmented.

- Show that that our theory can account for these patterns and more.
- Additional validation from interacting primary and secondary markets

  $\Rightarrow$ Cross market spreads and auction informativeness.

An Extremely Brief Literature Review

- **Sovereign debt**: focus on investors (not default decisions), primary markets.
- **Contagion**: force against diversification with a common pool of investors.
  - Endogenous winner's curse can break this link.
- **Auctions**: multi-unit + common value + CRRA + asymmetric information + interaction with an aftermarket. Trick to make it work: many bidders.
- **Information acquisition**: auctions, not competitive centralized markets.
  - "Grossman Stiglitz but with strategic complementarities."

Model

Model

- One period. Investment at beginning; payoffs at the end.

- Two governments indexed by $j \in \{1, 2\}$. Must raise **revenue** D_j.

  Auction bonds (simultaneously) with exogenous default and no recovery.

- Given state $\theta_j \in \{b, g\}$, default probability is $\kappa_j(\theta_j)$ with $\kappa_j(g) < \kappa_j(b)$.

  Unconditional default probability is $\bar{\kappa}_j = f_j(b)\kappa_j(b) + f_j(g)\kappa_j(g)$.

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- Unit **mass** of investors with CRRA utility $u(c)$ and endowment W.
  - Investors buy bonds or invest in risk-free storage. No borrowing.
- All investors have common prior about the states.
- Can learn the realization of θ_1 and/or θ_2 by paying a utility cost.

  Fraction of informed investors in country j: n_j
- Investors split into two traders; one for each j. No communication.

Auctions

- Primary market is run as a multi-unit discriminatory (pay your bid) auction.

- Each investor can submit any number of bids $\{\tilde{P}, \tilde{B}\}$ with $\tilde{B} \geq 0$.

  (a commitment to buy $\tilde{B}$ bonds at $\tilde{P}$, should government accept).

- Government accepts bids in decreasing price order until it raises D_j.

- Given many bidders, a unique **marginal price** for each state.
  - If only uninformed investors, a single price in each country, P_j.
  - If there are informed investors, prices are state-contingent, $P_j(\theta_j)$.

- WLOG: only bid at *possible* marginal prices (but still pay bid price).

  Denote i's bid at $P_j(\theta_j)$ by $B_j^i(\theta_j)$.

Investors can anticipate marginal prices, but cannot adjust bids ex-post.

Secondary Market

- Competitive market after auction with a single market-clearing price.
- No short sales, zero net supply.
- **Symmetric information** (because auction results are observable).
  If uninformed only ($n = 0$) then uninformed price and no trade.

Only trading motive: rebalancing portfolios after auctions.

Theory: Auction only

Bidding Strategies and Information

- Bidding strategies are solutions to a *portfolio problem.*
  - Simple for the informed: bid only at the correct marginal price.
  - Hard for the uninformed: bids at high prices accepted even when state is bad.

- Bonds in-the-money

$$\mathcal{B}_j^i(\theta_j) = \begin{cases} B_j^i(\theta_j) & \text{if } i \text{ is informed in } j \\ \sum_{\theta_j' : P_j(\theta_j') \geq P_j(\theta_j)} B_j^i(\theta_j') & \text{if } i \text{ is uninformed in } j. \end{cases}$$

- Total expenditure on risky assets (bonds in country j and state θ_j),

$$X_j^i(\theta_j) = \begin{cases} P_j(\theta_j) B_j^i(\theta_j) & \text{if } i \text{ is informed in } j \\ \sum_{\theta_j' : P_j(\theta_j') \geq P_j(\theta_j)} P_j(\theta') B_j^i(\theta') & \text{if } i \text{ is uninformed in } j. \end{cases}$$

Informed don't overpay in the bad state, avoid expenditure uncertainty.

Fear of winner's curse leads uninformed to bid less at high price.

Two Sequential Decision Problems (Reverse Order)

Definition (Portfolio Choice Problem- No Secondary)

$$V^i = \max_{\text{PM bids}} \quad \mathbb{E}^i\left[u(c^i(\vec{\theta}, \vec{\delta}))\right]$$

$$\text{s.t.} \quad B^i_j(\theta_j) \geq 0 \quad \text{for all } j \text{ and } \theta_j$$

$$w^i(\vec{\theta}) \geq 0 \text{ for all } \vec{\theta}.$$

Secondary markets add portfolio re-balancing stage.

Definition (Information acquisition problem)
Let ι denote type induced by $\{a_1, a_2\}$. Then choose information according to

$$\max_{\{a_1, a_2\}} V^\iota - C(a_1, a_2).$$

Given an information choice, what are the optimal bids?

- Marginal incentive to bid captured by MRS across default/repay:

$$M_j^i(\theta_j) = \frac{\sum_{\text{feasible } \theta_j \text{ with weakly lower prices}} \text{Prob}(\theta_j) u'(c^i(\theta_j) \text{ after default})}{\sum_{\text{feasible } \theta_j \text{ with weakly lower prices}} \text{Prob}(\theta_j) u'(c^i(\theta_j) \text{ after repayment})}$$

(modulo background risk coming from other country)

- **Marginal investor**'s MRS is equal to the equilibrium yield:

$$\frac{1 - P_j(\theta_j)}{P_j(\theta_j)} = M_j^*(\theta_j).$$

The informed is always the marginal investor.

Auction Clearing

- The market-clearing condition in country j and state θ_j is

$$\sum_i n^i X_j^i(\theta_j) = D_j.$$

If prices fall, government must issue more bonds.

Graphical Illustration: Prices

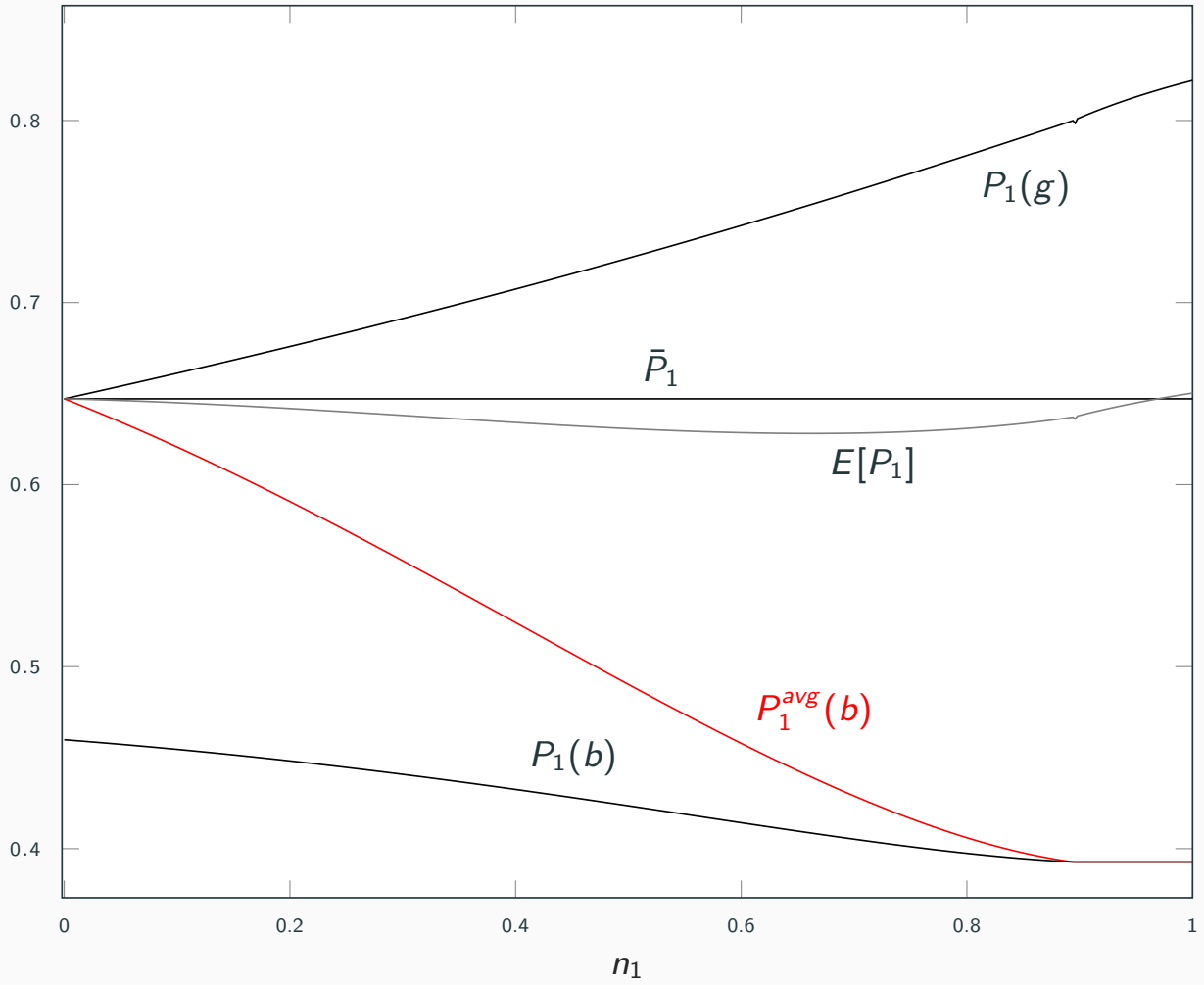


Figure 1: Prices in Country 1 as a function of n_1 given a fixed portfolio in Country 2.

Endogenous Information Acquisition

- The value of information is the utility difference $\Delta V = V^{\text{Informed}} - V^{\text{Uninformed}}$.
- It is driven by the winner's curse ($\approx P(g) - P(b)$) and the level of prices.

- **Fundamental factors:** fixing information choices, ΔV is increasing in
  - (i) High debt levels relative to wealth.
  - (ii) Higher average default risk.
  - (iii) Higher variance of default probabilities.

  $\Rightarrow$ Fundamental shocks can trigger information acquisition.

- **Endogenous factors:** Winner's curse increasing in informed investor share.

  $\Rightarrow$ Strategic complementarity that can lead to large changes in information.

Illustration: Strategic Complementarity

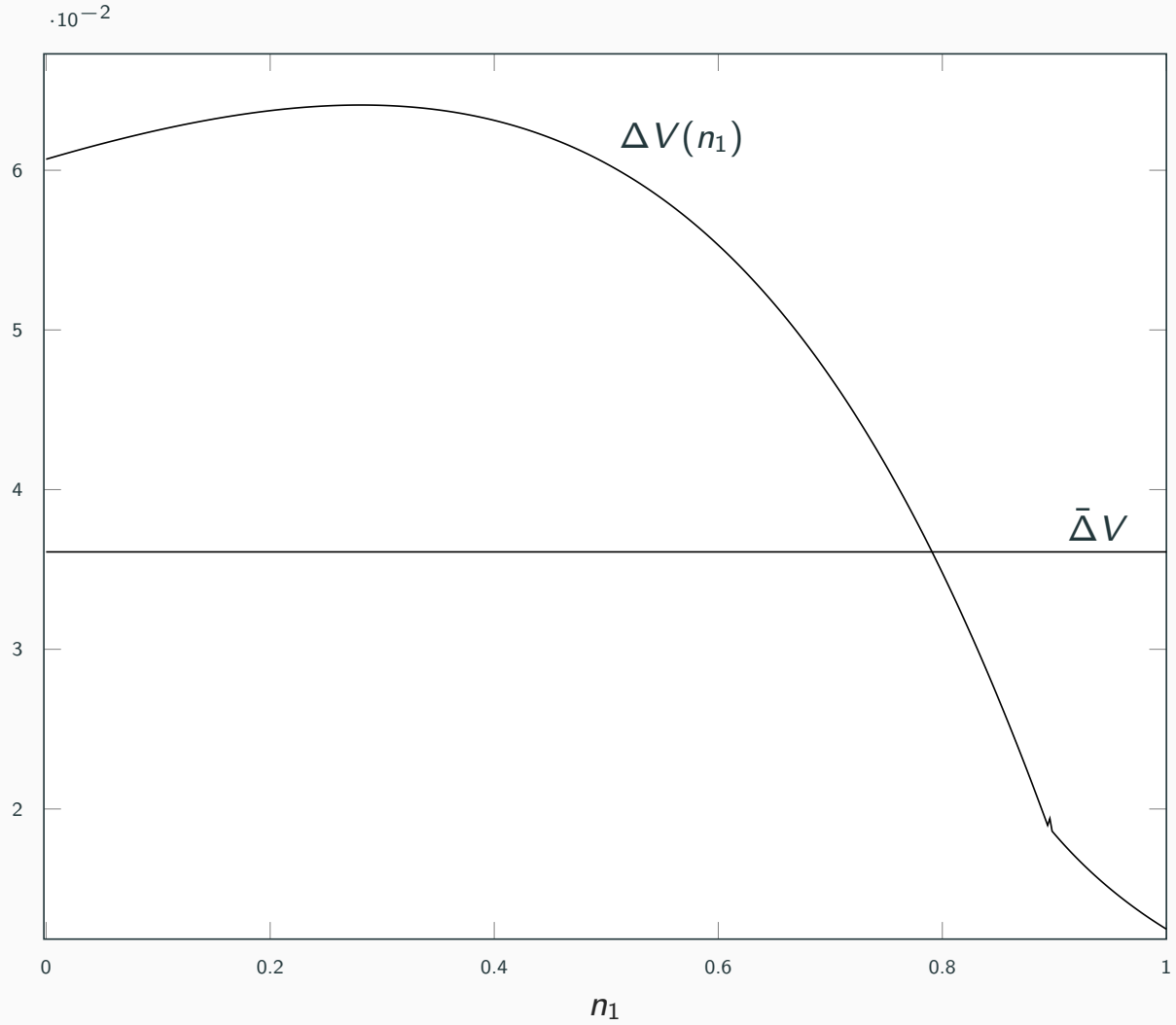


Figure 2: The value of information in Country 1 as a function of n_1.

Two Countries and Secondary Markets

Cross-Country Effects

1. **Symmetric information:** auction is irrelevant, obtain "standard" spillovers.
   - Cannot speak to segmentation or reverse spillovers.

2. **Asymmetric information:** segmentation and information spillovers
   - Informed exploit their information, uninformed "flee" to "ignorance havens".
   - Poor diversification $\implies$ higher price of risk.
   - Portfolio concentration $\implies$ value of information in "ignorance havens".
   - If those remain ignorance havens $\implies$ reverse spillovers.

Secondary Markets Effects

- Investors could wait to trade in a rather liquid secondary market.

- This turns out to **raise** rather than reduce the value of information.
  - Uninformed: avoid winner's curse at auction.
  - Informed: can exploit information advantage without holding default risk.
  - Information rents from **buying low at auction and selling high in SM.**
- Informed equilibrium more likely to exist with liquid secondary markets.

- Nice empirical upshots:
  - Auctions predicting secondary markets is a signal of information.
  - Primary-secondary spread is a measure of asymmetric information.

Application: Eurozone Debt Crisis

Key Facts from the Eurozone Crisis

- Focus on three large countries that use DP auctions: POR, ITA, GER.

  DP auctions also used in BEL, FRA, IRE, SWE, TUR... Hybrids used in ESP, AUS, FIN.

- Data from primary and secondary markets. Focus on 1-year bonds.
- Turbulent Times: Portugal hit in 2010, Italy later.

A taxonomy of key facts from the crisis:

	ITA/POR		GER	
	Pre	Post	Pre	Post
Yields	Low, stable	High, volatile	Low, stable	Low stable
Auct. Informativeness	No	**Yes**	No	**No**
PM-SM spread	Zero	**Positive**	Zero	**Zero**
Non-res share	High	**Decreasing**	Medium	**Increasing**

Key Facts from the Eurozone Crisis: Informativeness (1-year bond)

Define a price "surprise" as $\Delta \log \mathrm{P}_t = \log(P_t) - \log(E(P_t))$.

One-year Sovereign Bond: $\Delta \log \mathrm{Sec}_t$						
Country	Portugal		Italy		Germany	
Period	Before	After	Before	After	Before	After
$\Delta \log \mathrm{Prim}_t$	0.068	0.127^{***}	0.200^{***}	0.512^{***}	-0.080	0.068
	(0.069)	(0.043)	(0.065)	(0.054)	(0.081)	(0.043)
Observations	45	103	46	129	10	77
R^2	0.022	0.080	0.178	0.418	0.107	0.118

Table 1: Elasticity of SM prices to information released at auction. 1-year bond

Auction prices become (more) informative upon the crisis, not in GER.

Key Facts from the Eurozone Crisis: Primary-Secondary Market Spread

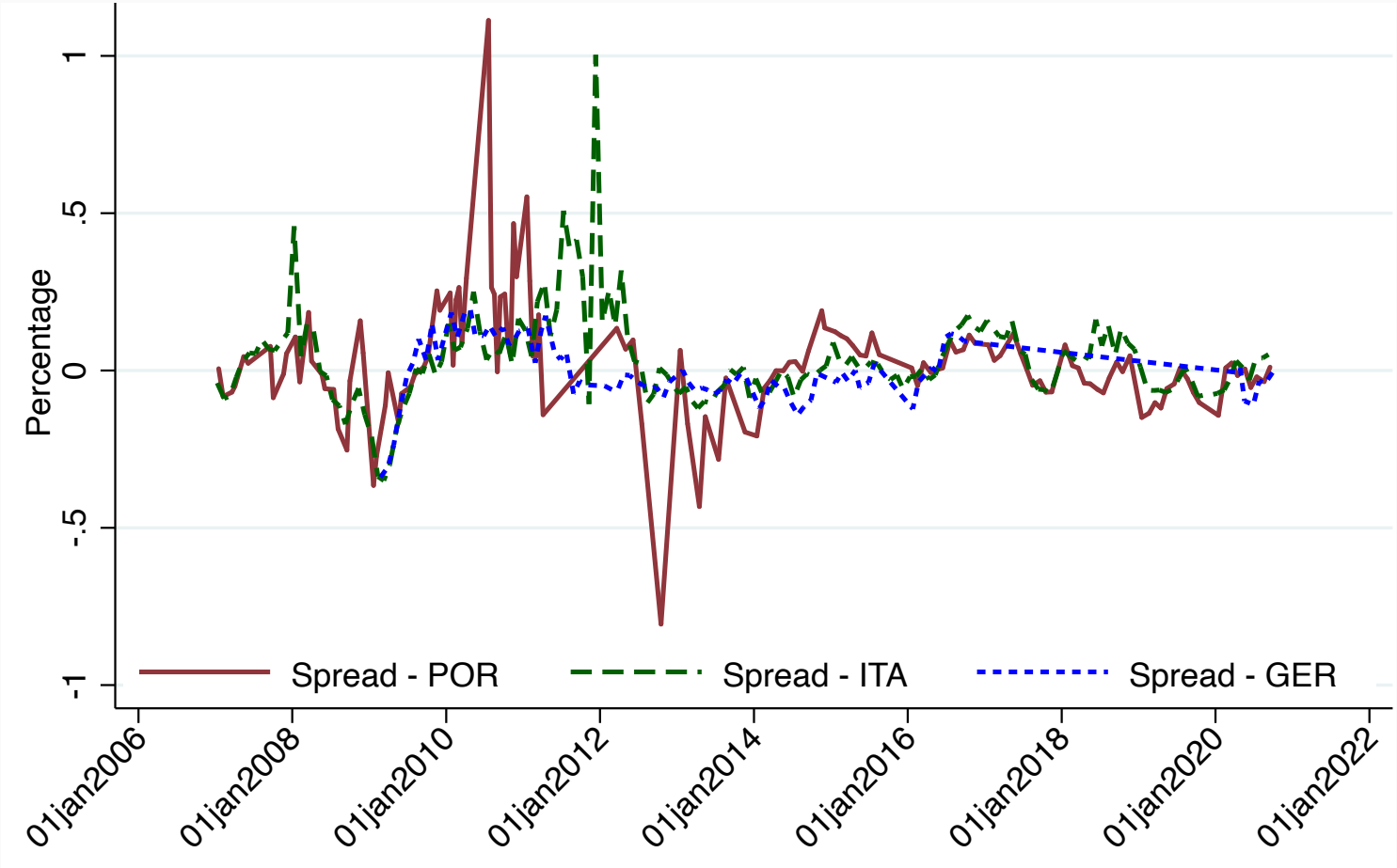


Figure 3: Cross-market spreads.

Cross-market spread appears in ITA and POR upon the crisis, not in GER.

Key Facts from the Eurozone Crisis: Segmentation

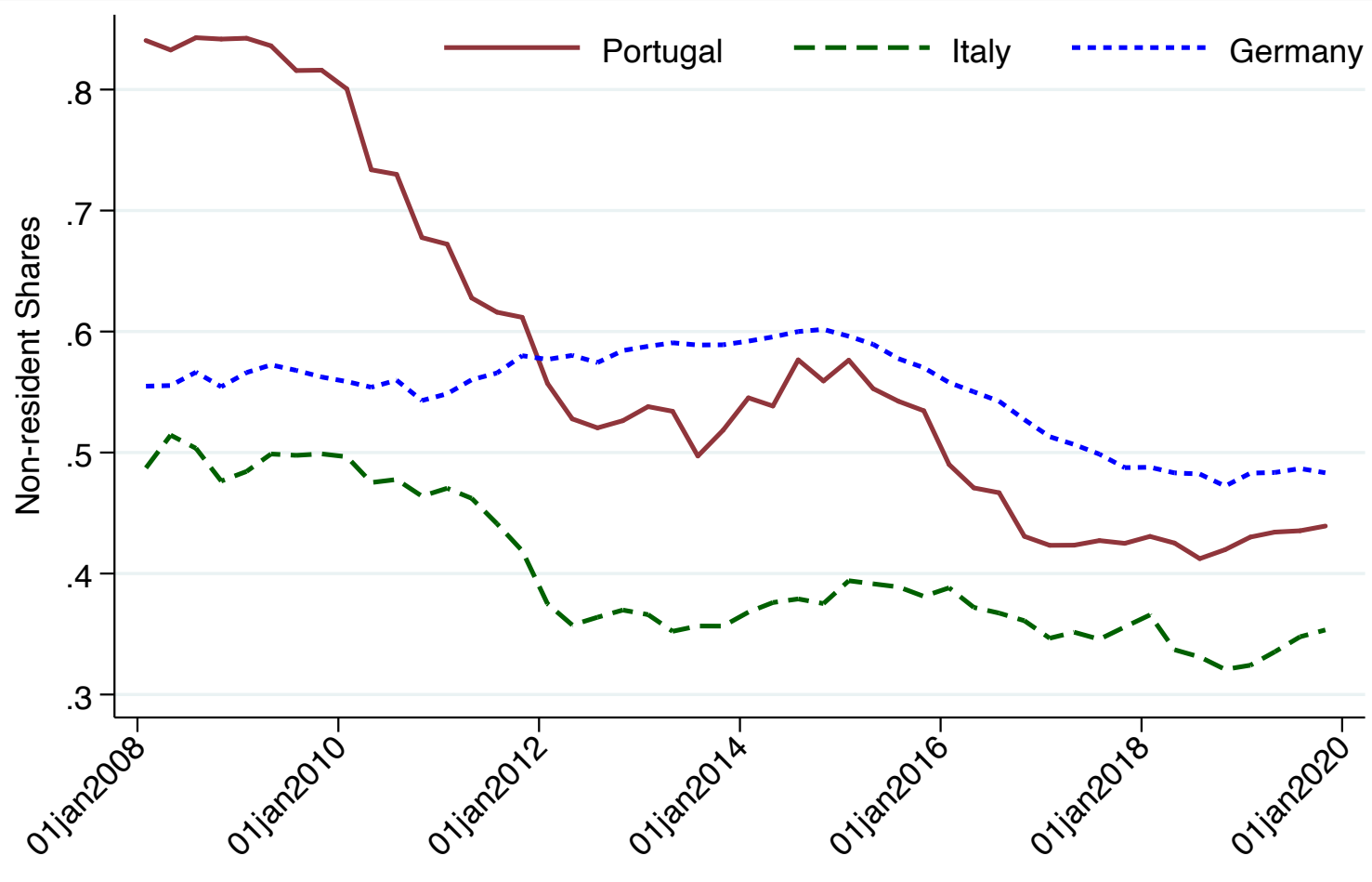


Figure 4: Non-resident Shares in POR, ITA, GER.

Pre-crisis, bond markets were well integrated. During *and after* crisis, non-resident share fell in ITA and POR, but not in GER.

Accounting for the Facts

- Consider repeated version of the basic model.
- Three groups of investors: core, periphery, global.
  - Differ only in information cost. Low at home, high abroad.
  - Probability of trading in secondary $= 0.75$
- Assume countries transition across different **public** "regimes."

	Tranquil regime	Alarming regime	Crisis regime
$\kappa(g)$	0.1%	0.5%	3%
$\kappa(m)$	0.5%	3%	7%
$\kappa(b)$	1.25%	7%	25%

$f(g) = 0.6$ and $f(m) = 0.3$ in all regimes.

- Conduct two "event studies" in the model:
  1. **Within-periphery:** spillovers from Portugal to Italy
  2. **Core-periphery:** reverse spillovers from periphery to Germany.

Within-Periphery Event Study

- Feed in the following regime shifts:

	Phase 1	Phase 2	Phase 3
Portugal	Tranquil	Alarming	Crisis
Italy	Tranquil	Tranquil	Alarming

- Information choice: **ITA becomes informed only because POR does.**

	Phase 1	Phase 2	Phase 3
Portuguese	Uninformed.	Uninformed	**Informed in Portugal**
Italian	Uninformed	Uninformed	**Informed in Italy**
Foreign	Uninformed	Uninformed	Uninformed

Core-Periphery Event Study

- Now assume there is an always stable country (i.e. GER).

	Phase 1	Phase 2	Phase 3
Periphery	Tranquil	Alarming	Crisis
Germany	Tranquil	Tranquil	Tranquil

- Information choice: **Germany too safe to induce information acquisition.**

Investor type	Phase 1	Phase 2	Phase 3
Periphery	Uninformed.	Uninformed	**Informed in Periphery**
German	Uninformed	Uninformed	**Uninformed**
Foreign	Uninformed	Uninformed	Uninformed

But...isn't this the ECB Monetary Policy Conference?

- We have assumed the alternative to bonds is risk-free storage.

  What if monetary policy (local or foreign) reduces risk-free rates?

  1. Increases bond prices (standard).
  2. Increases the value of information if investors are risk-averse enough ($> log$).

     $\Longrightarrow$ Reduces bond prices and increases their volatility.

- How about Central Banks' unconventional policies?

  1. Swapping bonds for private assets relaxes info pressures about those assets (Gorton and Ordonez, 2022).
  2. Buying bonds directly relaxes info pressures about those bonds (this paper).

Monetary policy affects the price level and volatility of government bonds by affecting the information regime in their primary markets.

Conclusion

New multi-country model of primary/secondary markets for sovereign debt.

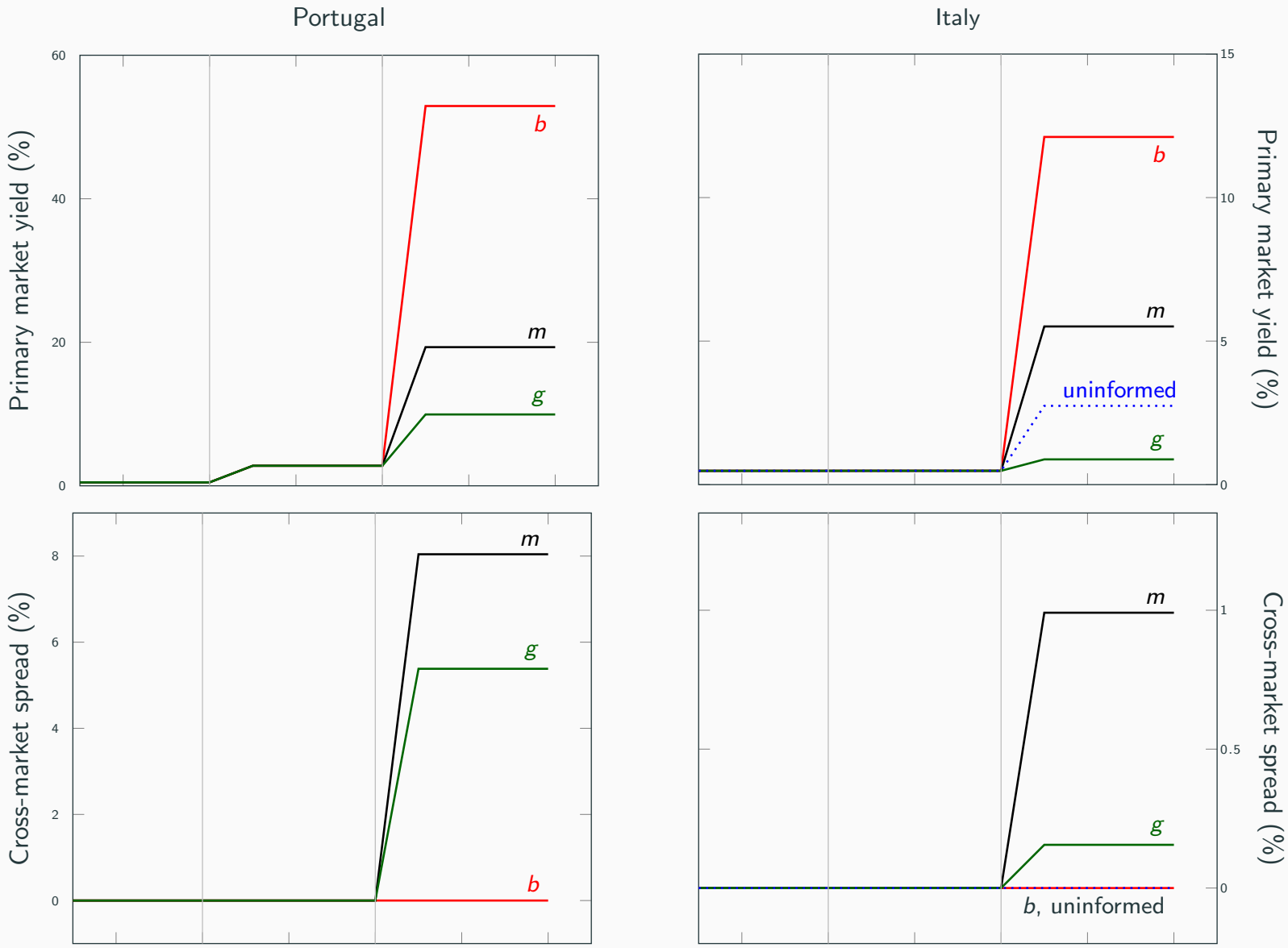
- Multi-unit auctions with discriminatory protocol and secondary markets.
- Common pool of risk averse investors.
- Endogenous information acquisition and information complementarities.
- Walrasian price-taking allows equilibrium determination.

Eurozone crisis provides nice validation of the basic mechanism.

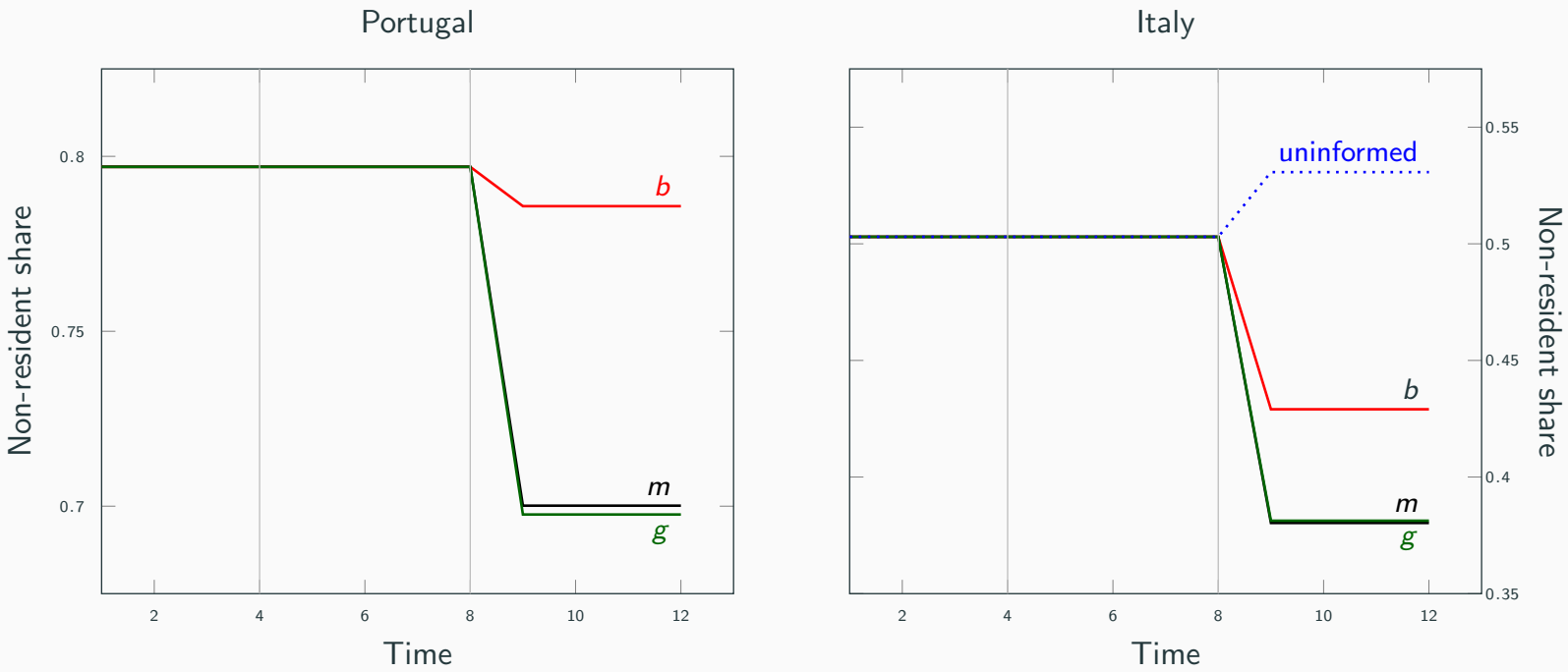
Theory and data highlight cross-country information externalities of how bond auctions are designed.

Extras

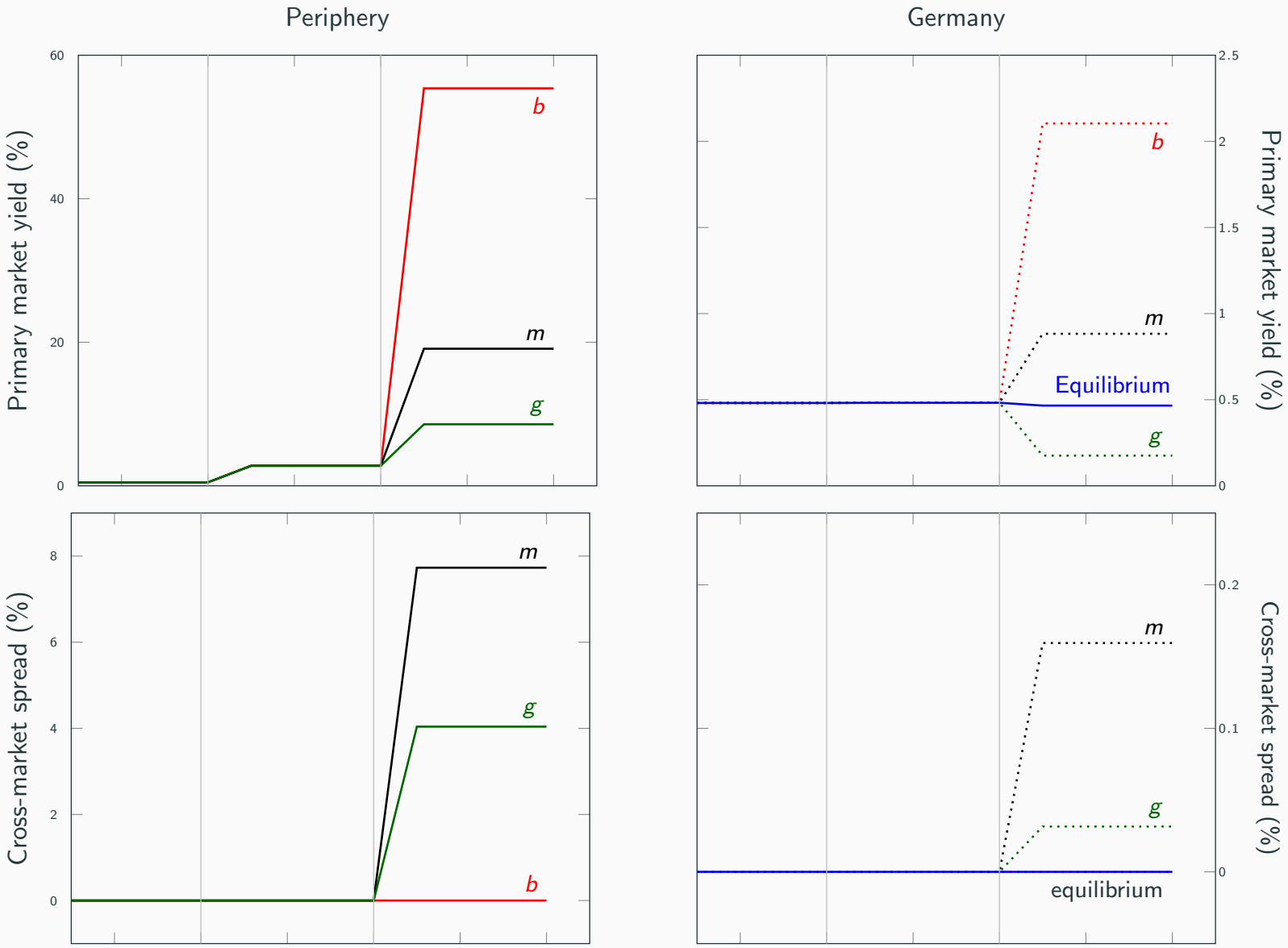
Portugal-Italy Spillovers: Yields



Within-Periphery Spillovers: Non-Resident Shares



Reverse Spillovers: Yields



Reverse Spillovers: Non-resident shares