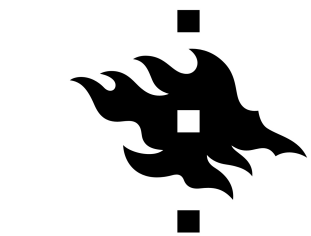
Sovereign Risk under Diagnostic Expectations

Stefan Niemann
University of Konstanz

Timm M. Prein
University of Helsinki

EEA Annual Congress
Bordeaux, August 2025



Motivation

- Sovereign spreads are generally highly volatile.
- Levels, volatility and frequency of crises vary substantially across emerging economies.
- Fundamentals explain only a limited share of spread movements.
- A substantial part seems to be driven by sentiment and expectations: **overreaction to current news**.

This Paper

- What are the implications of systematic overreaction to news for sovereign spreads and default risk?
- Does market optimism lead to overleveraging in good times, does pessimism entail excessive deleveraging in bad times?
- How should these dynamics be addressed by policymakers, e.g. in terms of fiscal rules?
- Dynamic stochastic model of sovereign debt featuring
  - endogenous default risk,
  - diagnostic expectations.

Main Results

- The model with diagnostic expectations matches the moments of spreads and debt at a more plausible (lower) default frequency than under rational expectations.
- The removal of diagnostic expectations promises sizeable welfare gains.
- Removing diagnostic expectations on the debtor's side accounts for more than 80% of welfare gains under rational expectations.
- Fiscal rules with debt or spread limits can generate sizeable welfare improvements.

Related Literature

- **Sovereign Debt and Default**
  - Eaton and Gersovitz (1981), Aguiar and Gopinath (2006), Arellano (2008)
  - Hatchondo and Martinez (2009), Chatterjee and Eyingungor (2012)
  - Pouzo and Presno (2016), Roch and Roldan (2023), Palusyznski (2023)
- **Sentiment and Diagnostic Expectations**
  - Bordalo, Gennaioli, and Shleifer (2018, 2022), Bordalo, Gennaioli, Shleifer, and Terry (2021), Al-Amine and Willems (2022)
- **Fiscal Rules**
  - Hatchondo, Martinez, and Roch (2022)

Diagnostic Expectations

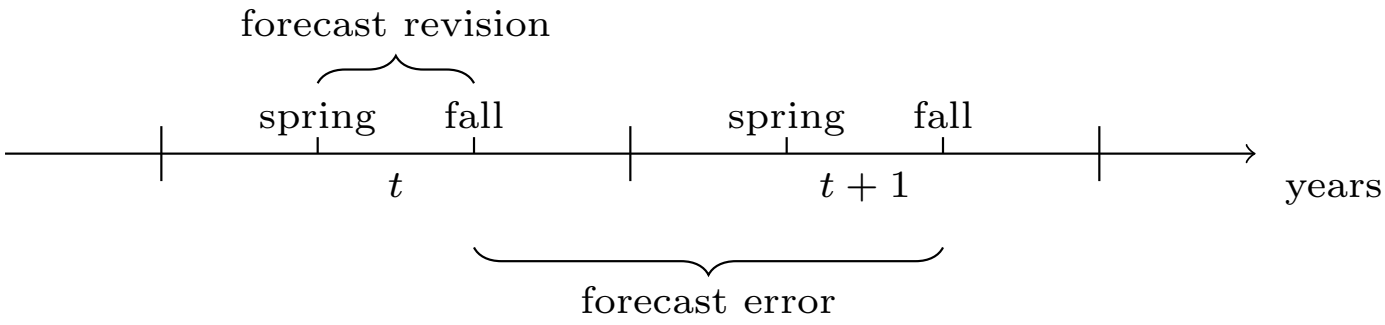
- Founded in psychology of selective recall, foundation for the overreaction of expectations e.g. in financial markets.
- **Idea:** if some news make a particular future outcome more likely relative to previous expectations
  $\rightarrow$ extrapolate the perceived likelihood of this outcome beyond the corresponding rational expectation
- Formally, for some random variable y_{t+1},

$$\mathbb{E}_t^{\gamma}(y_{t+1}) = \mathbb{E}_t(y_{t+1}) + \gamma \underbrace{\left[\mathbb{E}_t(y_{t+1}) - \mathbb{E}_{t-1}(y_{t+1})\right]}_{\text{forecast revision} \simeq \text{current news}}.$$

Spreads

Empirical Strategy

- GDP forecasts, 1990-2020, IMF's World Economic Outlook



- Overreaction ($\gamma > 0$) implies **negative correlation** between forecast revision and subsequent forecast error.

Strategy Details

Estimation

- WEO sample:

$$fe_{i,t} = \alpha_i + \beta_t + \theta \Delta E_{t-1}^{\gamma} \{g_{i,t}\} + \varepsilon_{i,t}$$

- Predictable forecast errors:

$$\hat{\theta} = \frac{Cov(fe_{i,t+1}, \Delta E_t^{\gamma} \{g_{i,t+1}\})}{Var(\Delta E_t^{\gamma} \{g_{i,t+1}\})} = -\frac{\gamma}{2(1+\gamma)}$$

- Diagnosticity:

$$\gamma = -\frac{2\hat{\theta}}{1+2\hat{\theta}}$$

Regression Results WEO Panel

	Dependent variable: forecast error	
	first-vintage, $fe_{i,t}$	final-release, $fe^{fin}_{i,t}$
	(1)	(2)
$\Delta E^{\gamma}_{t-1}\{g_{i,t}\}$	-0.075482^{***}	-0.066635^{***}
	(-4.808904)	(-3.487318)
	$\rightarrow \gamma = 0.18$	$\rightarrow \gamma = 0.25$
R^2	0.083410	0.074819
countries	194	194
observations	5345	5345

Regression Results LAC Panel and Argentina

	Dependent variable: forecast error			
	LAC panel		Argentina	
	first-vintage, $fe_{i,t}$	final-release, $fe^{fin}_{i,t}$	first-vintage, $fe_{i,t}$	final-release, $fe^{fin}_{i,t}$
	(1)	(2)	(3)	(4)
$\Delta E^{\gamma}_{t-1}\{g_{i,t}\}$	-0.176305^{**}	-0.150343^{**}	$\mathbf{-0.201268}$	-0.264978
	(-2.424928)	(-2.050303)	(-1.147158)	(-1.414288)
	$\rightarrow \gamma = 0.54$	$\rightarrow \gamma = 0.43$	$\rightarrow \gamma = 0.67$	$\rightarrow \gamma = 1.13$
R^2	0.251366	0.280780	0.044889	0.066673
countries	10	10	1	1
observations	300	300	30	30

The Model

Overview

- Small open endowment economy with infinitely-lived households.
- Benevolent government can issue external debt.
- International debt contracts are not enforceable.
- Risk-neutral international private lenders provide credit and charge a default premium.
- Baseline: All agents have diagnostic expectations.

Environment – Private Sector

- Preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t)$$

- Stochastic endowment y:

$$ln(y_t) = \rho ln(y_{t-1}) + \varepsilon_t,$$

where $|\rho| < 1$, and $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$.

Environment – Public Sector

- Long-term debt with stochastic maturity.
- Budget constraint, debt repayment:

$$c_t = y_t + (\delta + (1-\delta)\psi)b_t - q(b_{t+1}, y_t, \varepsilon_t)(b_{t+1} - (1-\delta)b_t)$$

- Budget constraint, default:

$$c_t = y_t - \phi(y_t)$$

Environment – International Private Creditors

- International private creditors are risk-neutral and refinance at risk-free rate r.
- They have perfect information about the country's endowment process y and they know how agents form their expectations.
- They have diagnostic expectations.

Environment – Diagnostic Expectations

- Following Bordalo et al. (2021), agents overreact to news:

$$E_t(ln\ y') = \rho ln(y) + \gamma\rho\varepsilon,$$

  where $\gamma \geq 0$.

- Expectations are rational if $\gamma = 0$.

Equilibrium – Public Sector

- Government decision conditional on a good credit standing

$$V^{\gamma}(b, y, \varepsilon) = \max\left\{V_R^{\gamma}(b, y, \varepsilon), V_D^{\gamma}(y, \varepsilon)\right\},$$

- Government – Repayment

$$V_R^{\gamma}(b, y, \varepsilon) = \max_{b'}\left\{u(c) + \beta \int_{y'} V^{\gamma}(b', y', \varepsilon')\mu(y', y, \varepsilon)dy'\right\}$$

such that

$$c = y + (\delta + (1-\delta)\psi)b - q(b', y, \varepsilon)(b' - (1-\delta)b)$$

Equilibrium – Public Sector

- Government – Default

$$V_D^{\gamma}(y,\varepsilon) = u(y_t - \phi(y_t)) + \beta \int_{y'} (1-\theta) V_D^{\gamma}(y',\varepsilon') + \theta V(0,y',\varepsilon') \mu(y',y,\varepsilon) dy'$$

- Default decision:

$$d(b,y,\varepsilon) = \begin{cases} 1 & \text{if } V_R^{\gamma}(b,y,\varepsilon) < V_D^{\gamma}(y,\varepsilon) \\ 0 & \text{else} \end{cases}$$

Equilibrium – International Private Creditors

- Bond price function follows from the zero-profit condition:

$$q^{\gamma}(b', y, \varepsilon)$$
$$= \frac{1}{1+r} \int_{y'} (1 - d(b', y', \varepsilon'))(\delta + (1-\delta)(\psi + q^{\gamma}(b'', y', \varepsilon'))\mu(y', y, \varepsilon)dy'$$

Quantitative Results

Functional Forms and Parameterization

$$u(c) = \frac{c^{(1-\sigma)}}{1-\sigma}$$

$$ln(y') = \rho ln(y) + \varepsilon', \quad \text{where } \varepsilon \text{ is i.i.d. } N(0, \sigma^2)$$

$$E(ln\ y') = \rho ln(y) + \gamma\rho\varepsilon$$

$$\phi(y) = \max\{\xi_0 y + \xi_1 y^2, 0\}, \quad \text{where } \xi_1 \geq 0$$

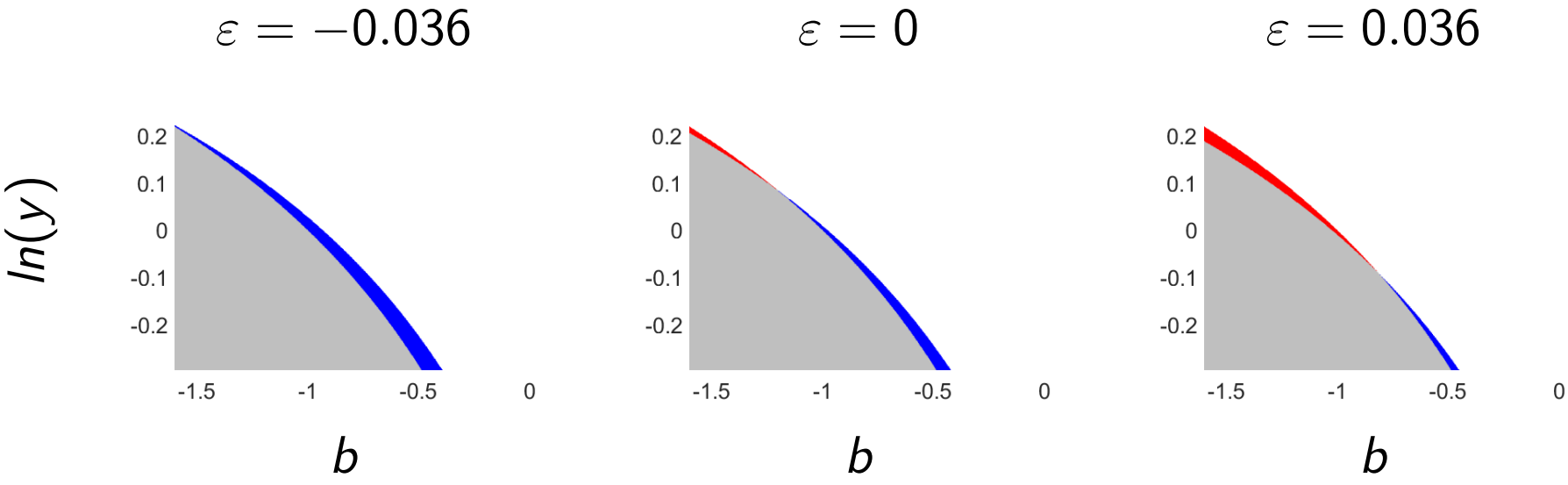
Parameter	Description	Value	
		Diagnostic	Rational
Externally calibrated parameters			
r	Risk-free rate	0.01	
σ	Relative risk aversion	2.0	
ρ	Autocorrelation	0.930139	
σ_ε	Standard deviation of ϵ	0.027209	
δ	Maturing Probability	0.05	
θ	Reentry probability	0.0385	
ψ	Coupon Payment	0.03	
γ	Diagnostic factor	**0.67**	**0**
Internally calibrated parameters			
β	Discount factor	0.9585	0.9535
ξ_0	Output cost (intercept)	-0.1576	-0.2636
ξ_1	Output cost (slope)	0.2211	0.3258

Model Fit

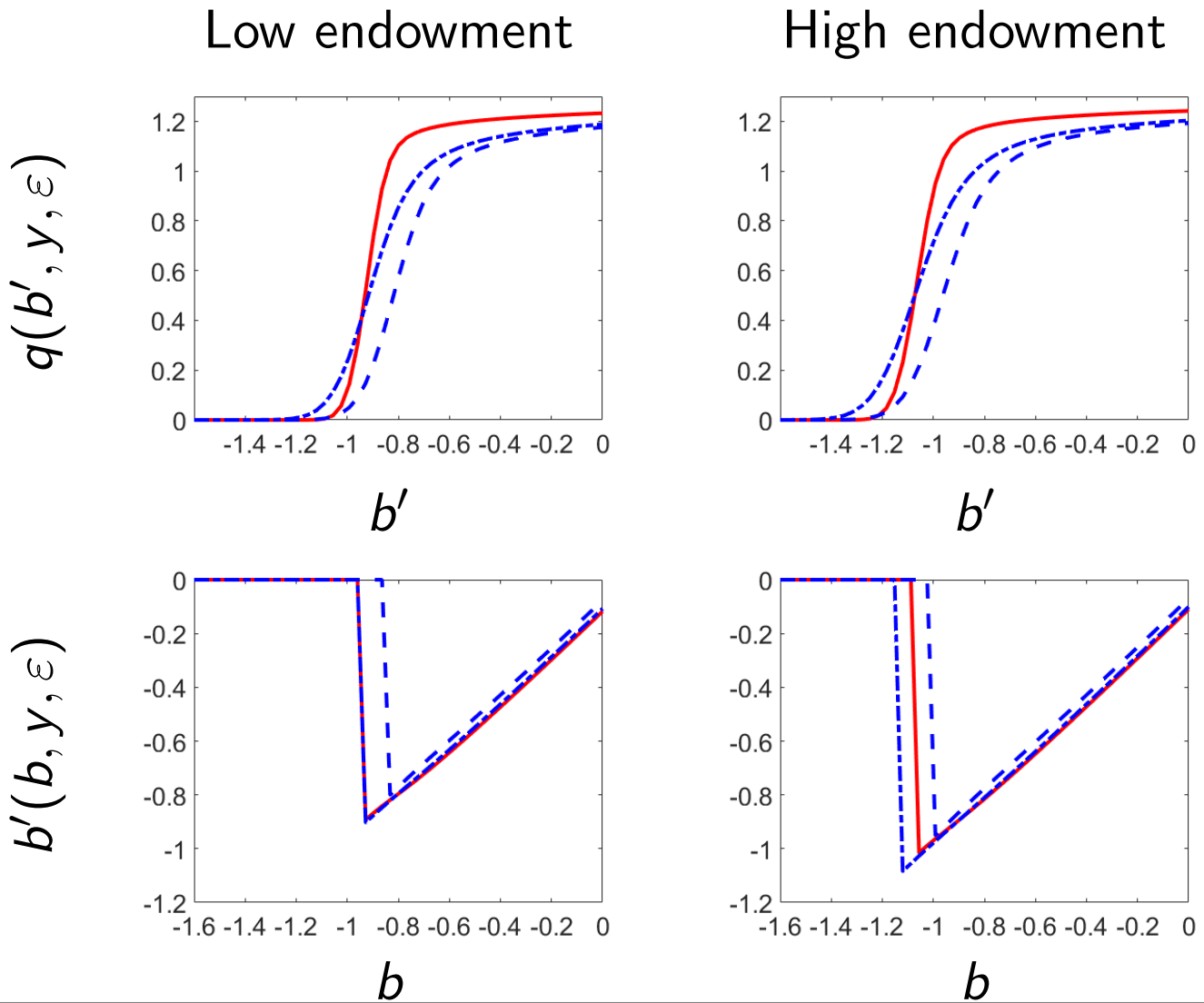
Calibration targets	**Data**	**Simulations**	
		Diagnostic	**Rational**
E (debt/GDP)	70.00	70.00	70.11
E (spread)	8.15	8.15	8.17
std (spread)	4.43	4.48	4.43

untargeted: default frequency, about 3% annually

Default Decision



Debt Policy and Bond Price Functions



Legend: — DE — RE

Business Cycle Statistics

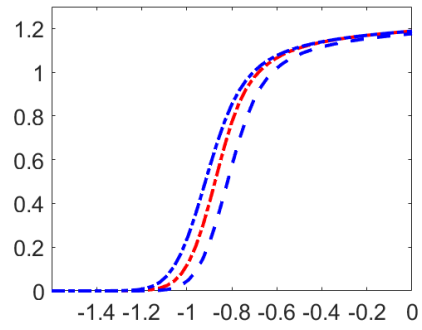
	(1) Data	(2) Diagnostic $\gamma = 0.67$	(3) Diagnostic $\gamma = 0$	(4) Rational
$\sigma(c)/\sigma(y)$	1.09	1.05	1.03	0.99
$\sigma(TB/y)/\sigma(y)$	0.17	0.29	0.28	0.29
$\sigma(s)$	4.43	4.48	1.81	4.43
$\rho(c, y)$	0.98	0.96	0.96	0.96
$\rho(TB/y, y)$	−0.88	−0.24	−0.22	−0.17
$\rho(s, y)$	−0.79	−0.67	−0.70	−0.63
$E(s)$	8.15	8.15	3.97	8.17
Max. s	29.71	51.89	18.02	40.30
Mean debt output ratio (%)	70.00	70.00	80.83	70.11
Mean drop in y (at default)	−6.4	−5.78	−5.05	−4.43
Default frequency (%)		**0.62**	**0.81**	**1.59**
Welfare equivalent (in %)	–	–	0.65	–

Spreads Impulse Responses

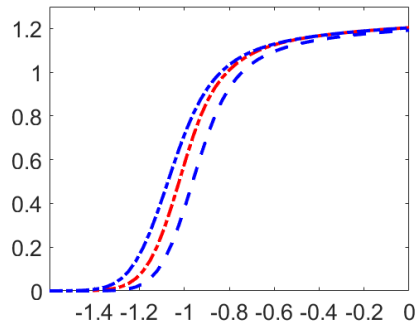
Asymmetric Settings

1. DE government, RE creditors

Low endowment



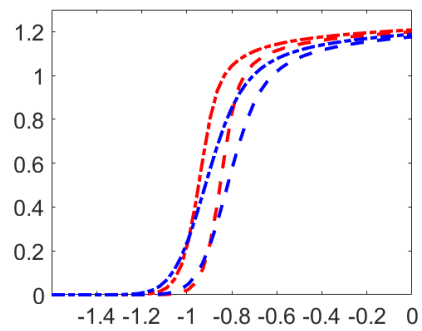
High endowment



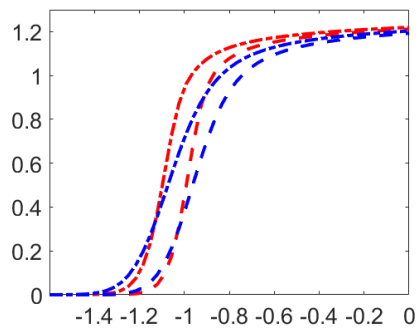
$q(b', y, \varepsilon)$

2. RE government, DE creditors

Low endowment



High endowment



$q(b', y, \varepsilon)$

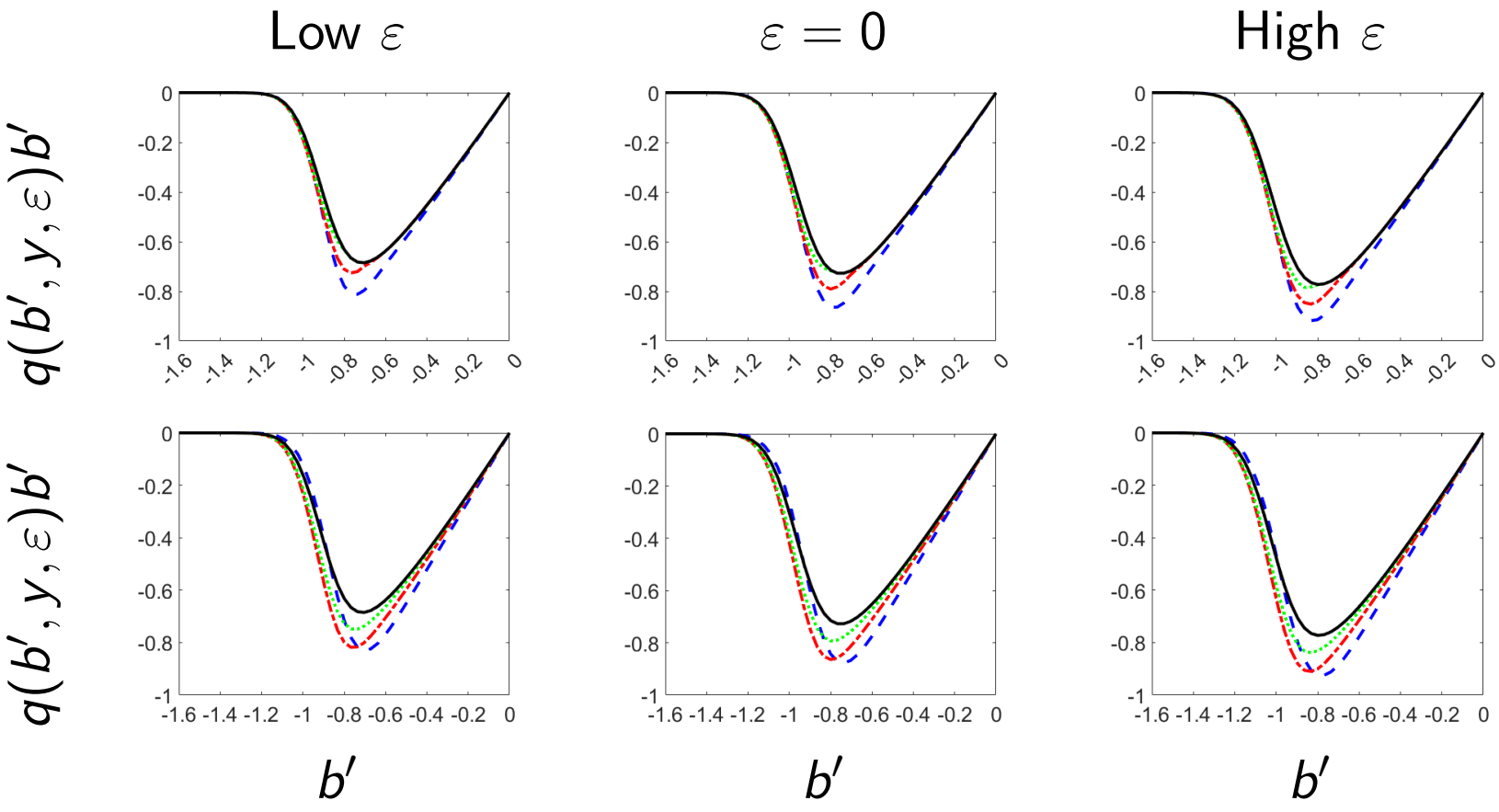
Business Cycle Statistics – Asymmetric Expectations

	(1) Diagnostic	(2)	(3) DE gvnt. RE cred.	(4) RE gvnt. DE cred.
	$\gamma = 0.67$	$\gamma = 0$	$\gamma = 0.67$	$\gamma = 0.67$
$\sigma(c)/\sigma(y)$	1.05	1.03	0.97	1.09
$\sigma(TB/y)/\sigma(y)$	0.29	0.28	0.29	0.25
$\sigma(s)$	4.48	1.81	5.32	3.62
$\rho(c, y)$	0.96	0.96	0.95	0.97
$\rho(TB/y, y)$	−0.24	−0.22	−0.07	−0.32
$\rho(s, y)$	−0.67	−0.70	−0.58	−0.55
$E(s)$	8.15	3.97	8.29	5.68
Max. s	51.89	18.02	61.48	157.77
Mean debt output ratio (%)	70.00	80.83	72.14	75.02
Default frequency (%)	0.62	0.81	1.44	0.09
Welfare equivalent (in %)	–	**0.65**	**−0.01**	**0.57**

Expectations and Fiscal Rules

- Expectations matter: (i) future output, and (ii) future budget balances and default
- Welfare costs of diagnostic expectations predominantly rooted on borrower side
- Together with debt dilution problem, rationale for fiscal rules
- Two possible forms:
  1. **Debt brake** $\bar{b}$ such that $b' \geq \min\left\{\bar{b}, b - \lambda\right\}$
  2. **Spread brake** $\bar{r}_s$, implying state-dependent $\bar{b}_s(y, \varepsilon, \bar{r}_s)$ such that $b' \geq \min\left\{\bar{b}_s(y, \varepsilon, \bar{r}_s), b - \lambda\right\}$
- Spread brake contaminated by non-fundamental spreads

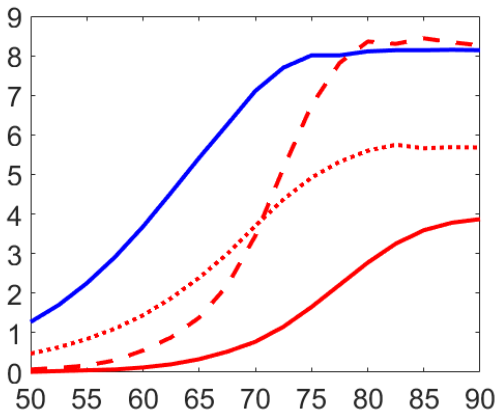
Fiscal rules – Borrowing Set



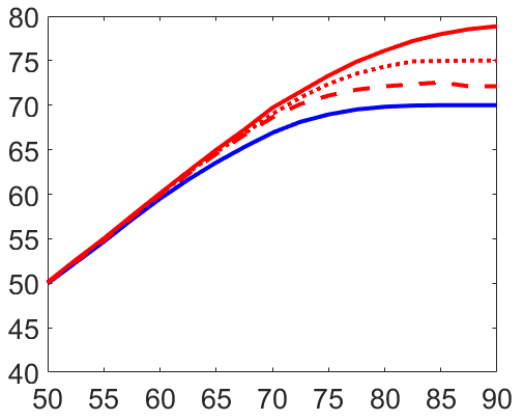
- Top panels: debt brake rule with $\bar{b} \in \{60\%, 70\%, 80\%\}$
- Bottom panels: spread brake rule with $\bar{r}_s \in \{0.5\%, 3.5\%, 7\%\}$

Debt Brake – Outcomes under Varying Diagnosticity

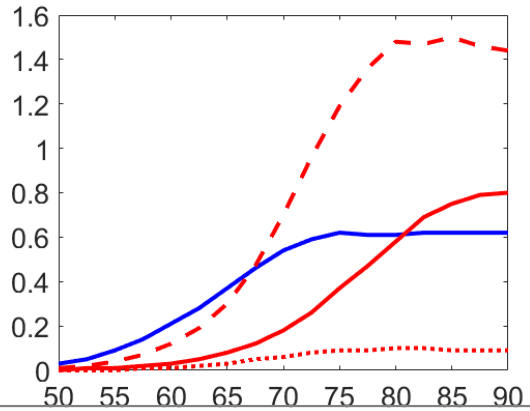
Mean Spread



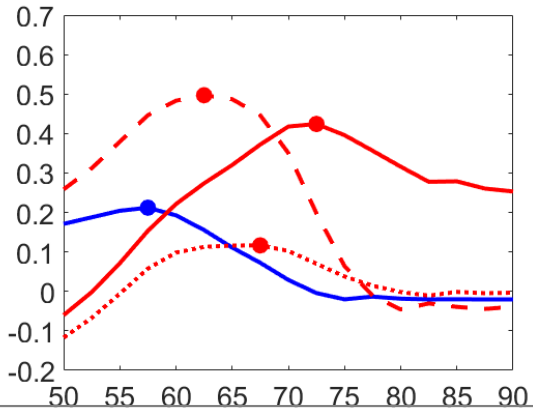
Mean Debt to Output



Default Frequency



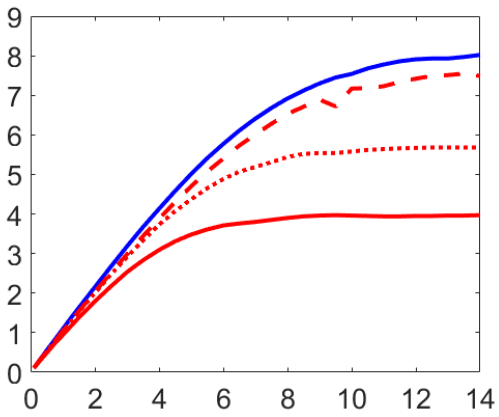
Welfare Equivalent



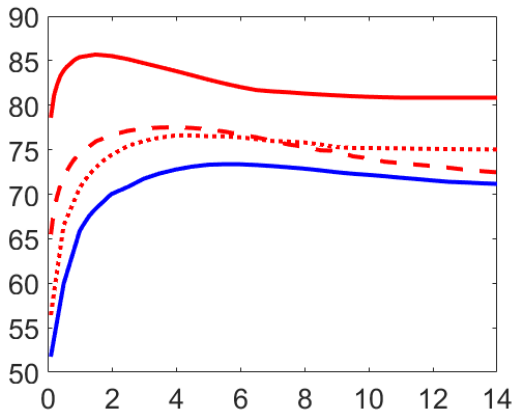
Legend: — DE — RE - - DE/RE ··· RE/DE

Spread Brake – Outcomes under Varying Diagnosticity

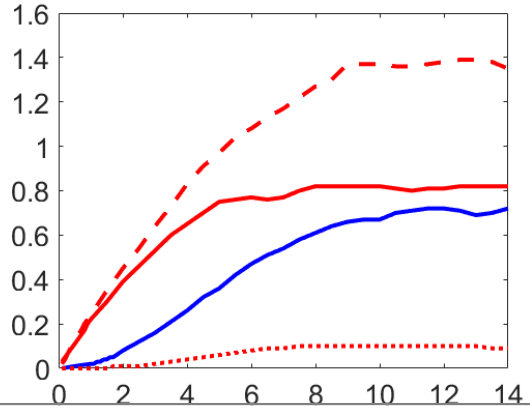
Mean Spread



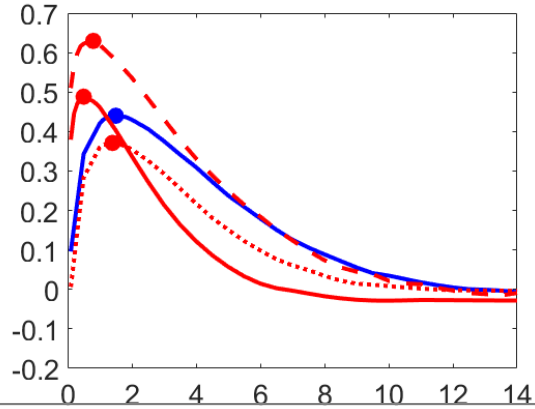
Mean Debt to Output



Default Frequency



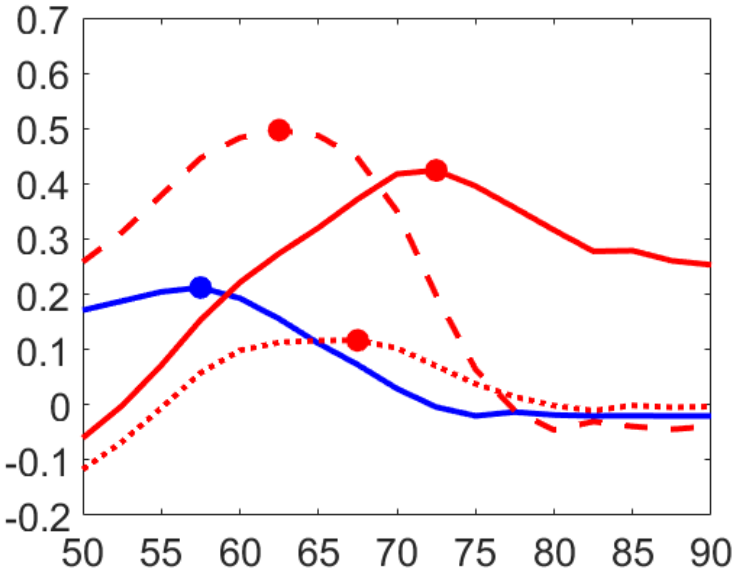
Welfare Equivalent



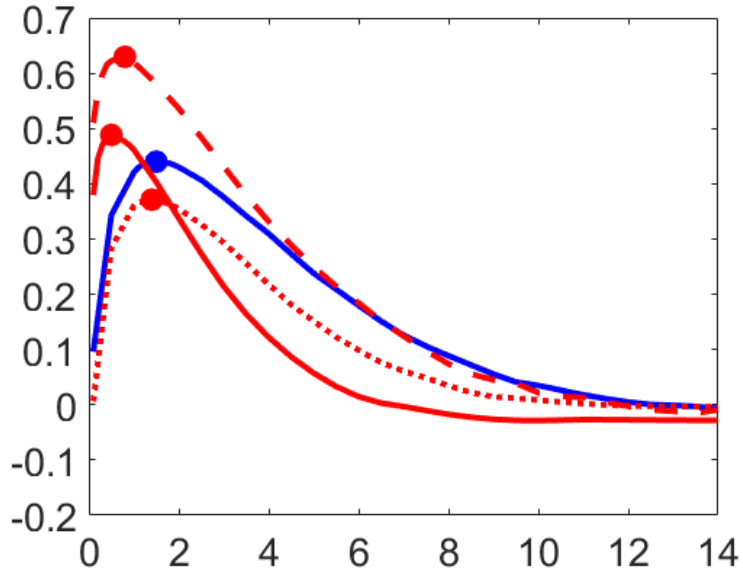
Legend: — DE — RE - - DE/RE ··· RE/DE

Welfare Effects

Debt Brake



Spread Brake



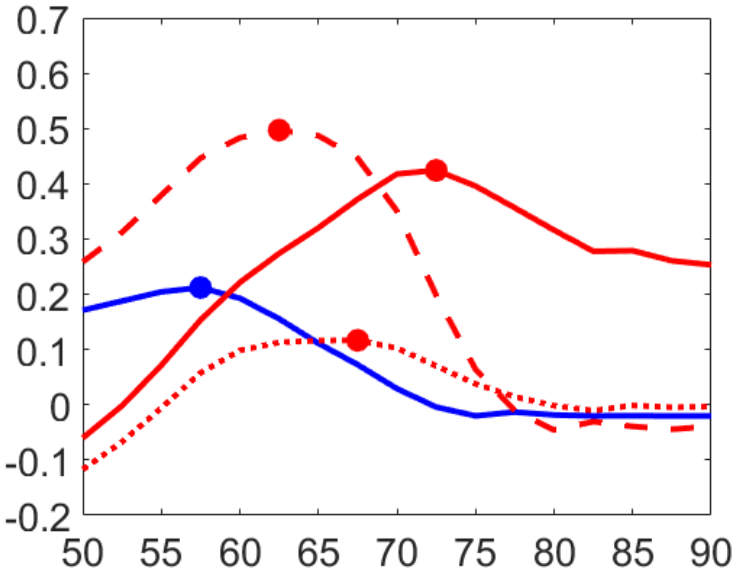
- **Debt brake:**
  - Potential for sizeable welfare gains, largest in DE/RE setting
  - Optimal tightness varies substantially, mostly driven by demand side
  - Excessive tightness detrimental, particularly when gvnt. is rational

---

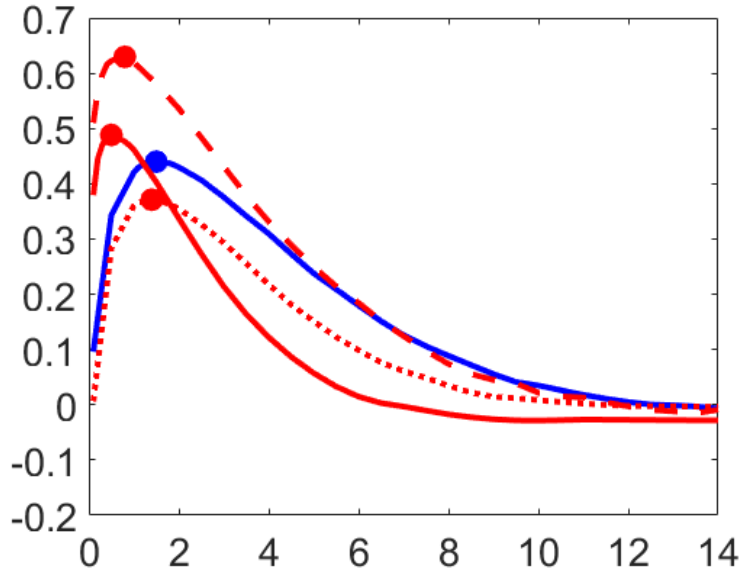
Legend: — DE — RE - - DE/RE ··· RE/DE

Welfare Effects

Debt Brake



Spread Brake



- **Spread brake:**
  - Potential for even higher welfare gains
  - Shift between DE/RE and DE baseline reflects cost of conditioning on non-fundamental spreads
  - Optimal tightness mostly driven by supply side

Legend: — DE — RE - - DE/RE ··· RE/DE

Question

- What are the implications of diagnostic expectations in a quantiative model of sovereign debt?

Main Results

- The model with diagnostic expectations matches the moments of spreads and debt at a more plausible (lower) default frequency than under rational expectations.
- The removal of diagnostic expectations promises sizeable welfare gains, where the debtor's side accounts for more than 80% of welfare gains under rational expectations.
- Fiscal rules can generate welfare improvements. Stability
- Spread brake offers robustness and generally performs better.

Spread Dynamics

- first-order approximation:

$$s_t \approx (1-\rho)s_\infty + \rho s_{t-1} - s\rho(1+\gamma)\epsilon_t + s\gamma\rho^2\epsilon_{t-1}$$

  - systematic mean-reversion, driven by fundamentals
  - contemporaneous amplification (ϵ_t)
  - followed by systematic reversal (ϵ_{t-1})

Back

Empirical Strategy

- AR(1) fundamental dynamics: $g_{i,t} = \rho\, g_{i,t-1} + \epsilon_{i,t}$
- End-of-period (fall) diagnostic forecast under current news $\epsilon_{i,t}$:

$$E_t^{\gamma}\left\{g_{i,t+1}\right\} = \rho\, g_{i,t} + \gamma\rho\epsilon_{i,t}$$

- Within-period (spring to fall) revision:
  $\Delta E_t^{\gamma}\left\{g_{i,t+1}\right\} = (1+\gamma)\rho\Delta_{sf}\epsilon_{i,t}$, with $\Delta_{sf}\epsilon_{i,t} = \epsilon_{i,t}^{f} - \epsilon_{i,t}^{s}$
- Forecast error based on expectations formed in fall of year t, recorded in $t+1$:

$$fe_{i,t+1} = g_{i,t+1} - E_t^{\gamma}\left\{g_{i,t+1}\right\} = \epsilon_{i,t+1} - \gamma\rho\epsilon_{i,t}$$

Back

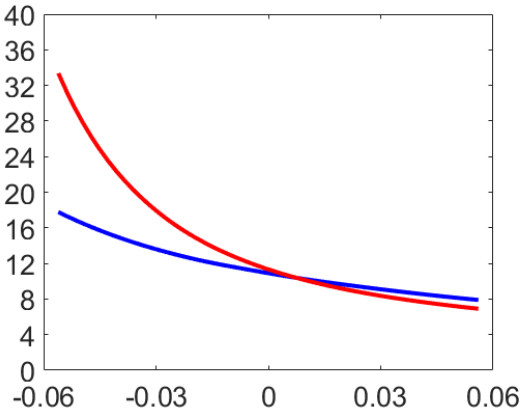
Spread Distribution

	(1) Data	(2) Diagnostic $\gamma = 0.67$	(3) Diagnostic $\gamma = 0$	(4) Rational
$Q_{0.10}(s)$	4.40	4.23	2.26	4.22
$Q_{0.25}(s)$	5.98	5.36	2.79	5.25
$Q_{0.50}(s)$	7.42	6.93	3.48	6.72
$Q_{0.75}(s)$	8.45	9.2	4.44	8.98
$Q_{0.90}(s)$	11.64	12.71	5.89	12.75

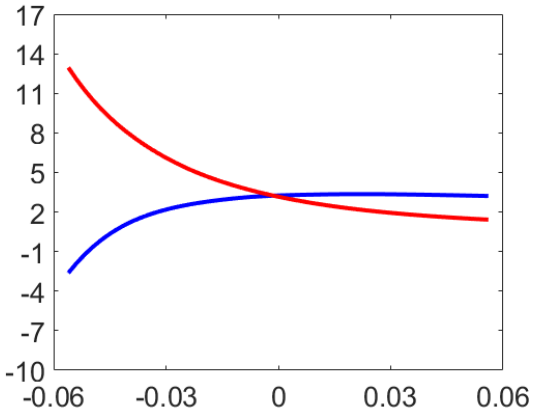
Back

Impulse Responses

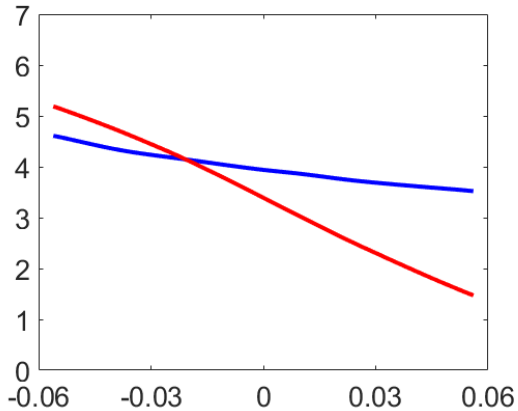
Spread



Spread Change



Trade Balance

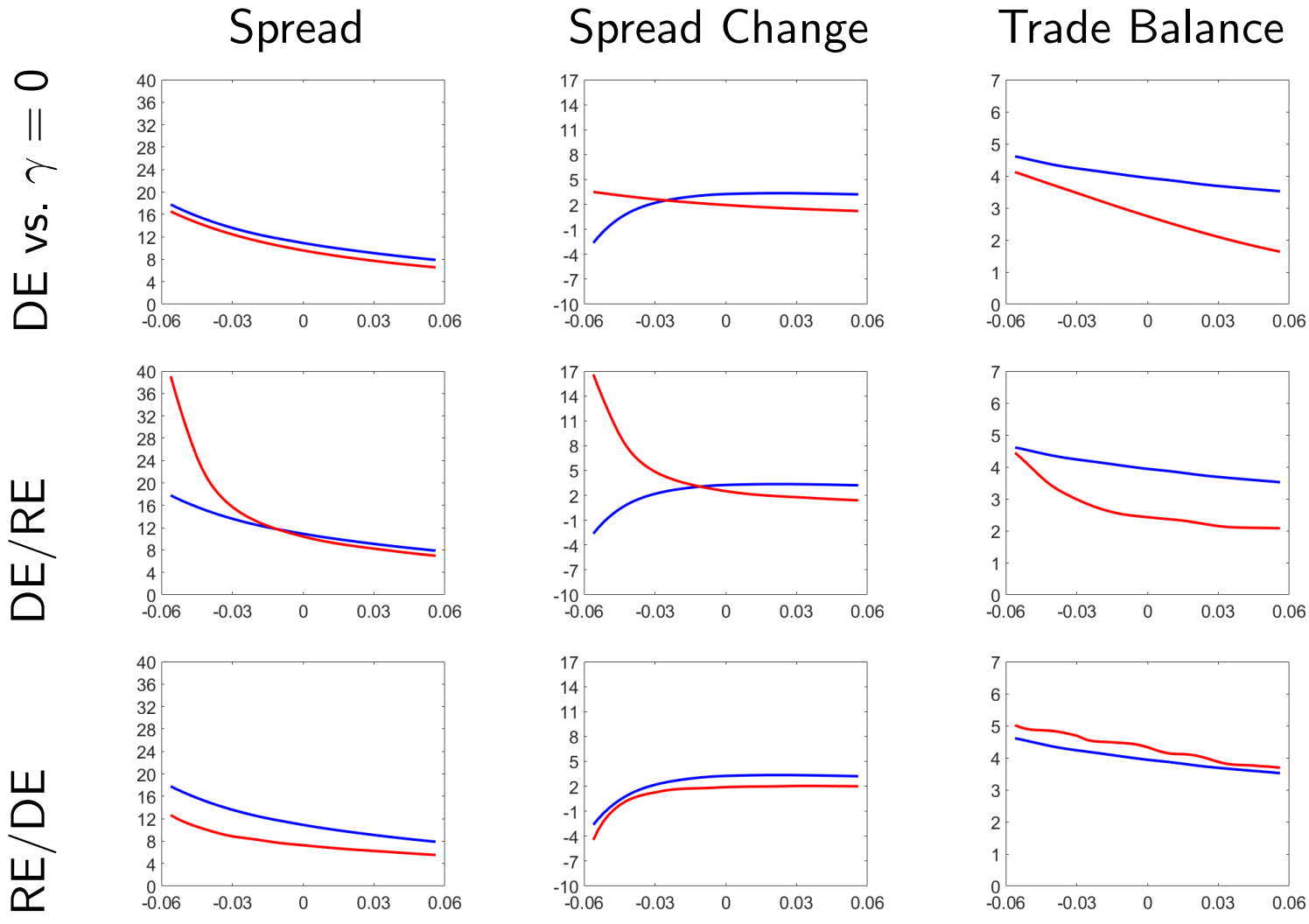


- Impulse responses to $\varepsilon_2 < 0$, depending on ε_1

  Legend: — DE — RE

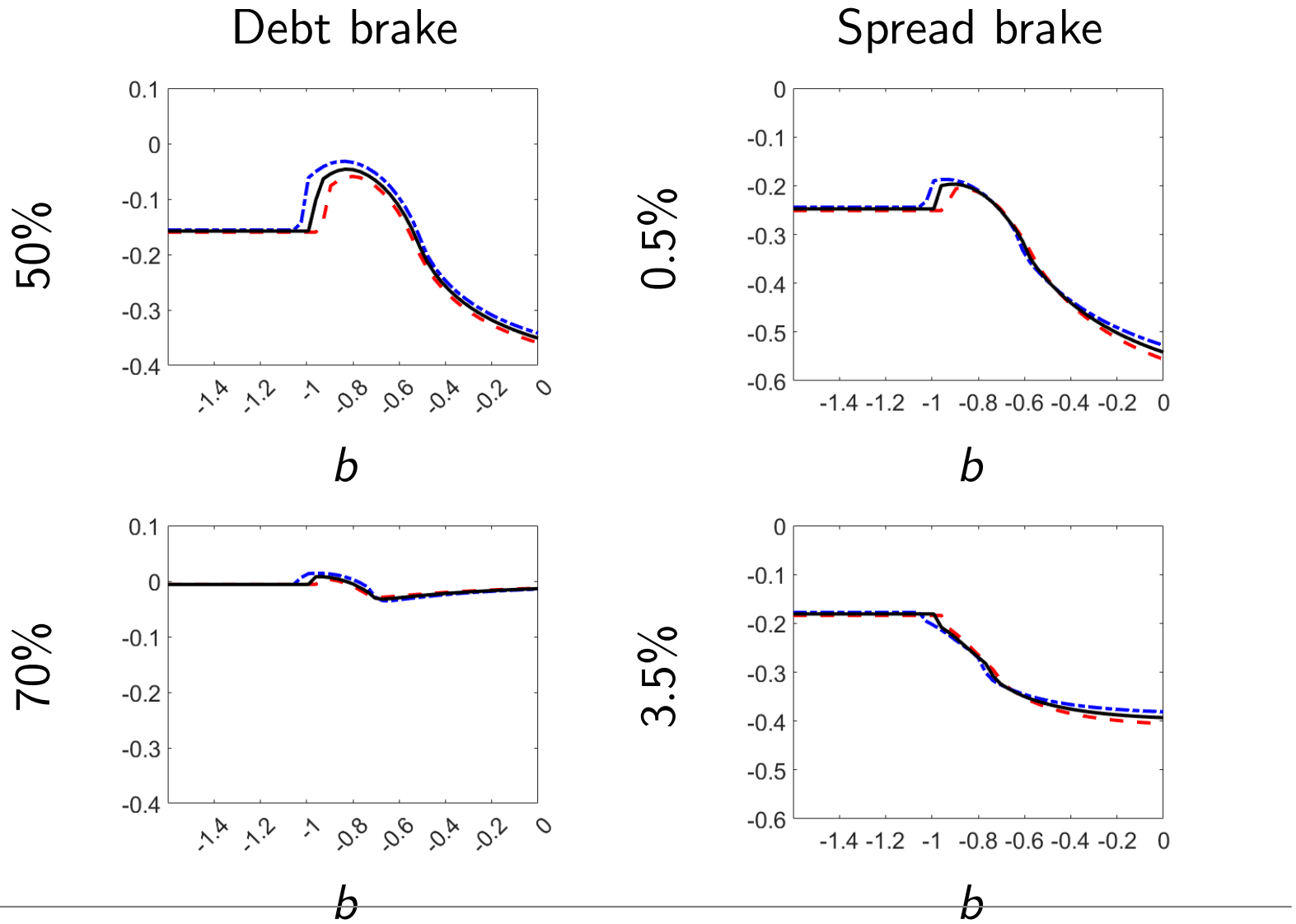
Back

Impulse Responses – Asymmetric Expectations



Back

Fiscal Rules – Welfare Penalty to Avoid (Permanent) Exit (DE)



Back