The Pricing of Sovereign Risk Under Costly Information

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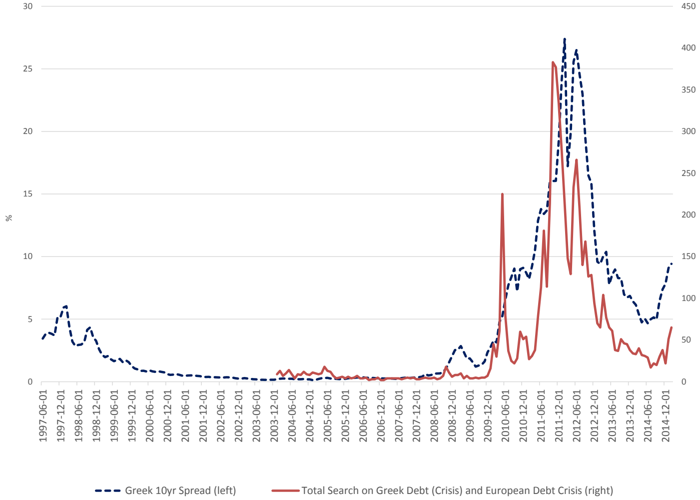
Motivation

- Attention paid to sovereign nations is not constant
  - Emerging market fund managers use ‘flags’
  - Attention increases during crises

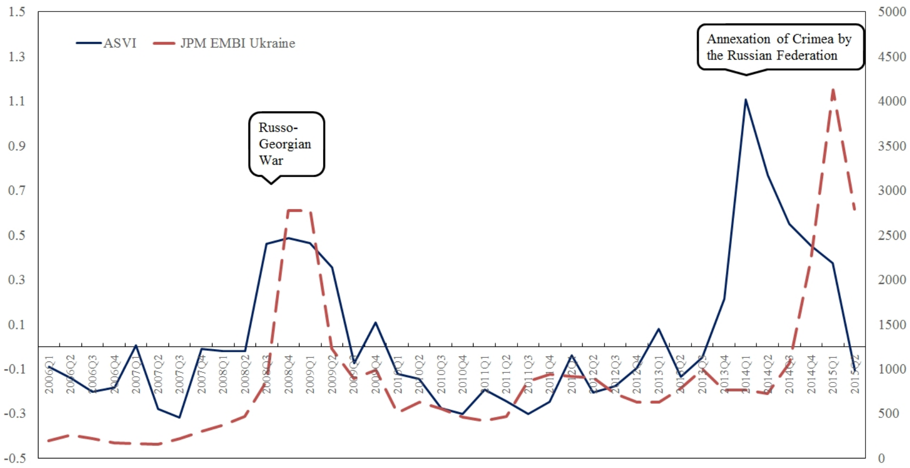
Motivation

Sovereign Spreads versus Google Search Volume Index:



Motivation

Figure: Quarterly ASVI for the Search Term "Ukraine IMF"



Motivation

- Research question:
  What is the role of forecasters/investors' attention in the pricing of sovereign debt?

- Why important:
  - Fit well for less informative EM sovereign bond markets
  - Provide a richer lender-side theory $\rightarrow$ Generate non-trivial results for spread dynamics, default risk inference, and policy implications
  - Generate endogenous time-varying volatility

Our Contributions Relative to Literature (optional)

- Role of private information for sovereign debt pricing
  - Cole and Kehoe, 1998; Sandleris, 2008; Catao, Fostel, and Kapur, 2009; Phan, 2015; Pouzo and Presno, 2015; Blot, Ducoudre, and Timbeau, 2016
  - Use investors' attention allocation problem

- Endogenous investor attention
  - Sims, 2003; Reis, 2006; Barber and Odean, 2007; Andrei and Hasler, 2015; Mackowiak and Wiederholt, 2009, 2014, 2015
  - Financial assets & intl finance: Andrei and Hasler, 2014; Bacchetta and van Wincoop, 2010; van Nieuwerburgh and Veldkamp, 2009, 2010
  - Interact with sovereign's states and its debt pricing
  - Estimate info cost by targeting Google search volume index on relevant search phrases (Da, Engelberg, and Gao, 2011)

Our Contributions Relative to Literature (optional)

- Time-varying volatility
  - Bloom, 2009; Fernandez-Villaverde, Guerron-Quintana, Rubio-Ramirez, and Uribe, 2011; Justiniano and Primiceri, 2011; Curran, 2015; Seoane, 2015; Johri et al., 2015
  - Endogenize and amplify time-variation in sovereign spread volatility
- Default-risk inference
  - Bi and Traum, 2012; Lizarazo, 2013; Stangebye, 2015; Bocola, 2016; Bocola and Dovis, 2016; Cimadomo, Claeys, and Poplawski-Ribeiro, 2016
  - Provide a new layer of uncertainty premium that is state contingent
    - sovereign spread = Default risk + Observed states' future uncertainty premium + Unobserved info uncertainty premium
    - Bias in econometric estimates of default risk from yield data

Model Environment

- Like many sovereign default models:
    1. Small open economy, stochastic endowment
    2. Govt. maximizes household utility, and issues 1-period non-state-contingent defaultable bonds to risk-averse foreigners
    3. Default $\Longrightarrow$ No debt; endowment loss; financial autarky with return probability θ
- New in this model:
    1. Observed growth shock s (Aguiar and Gopinath, 2006) + Unobserved default output cost shock m (one-time, i.i.d., known marginal distribution)
    2. Both info can affect borrower's default decisions
    3. Forecasters' costs in terms of attention to obtain relevant info about m
    4. Forecasters' endogenous optimal attention choice $\rightarrow$ choose a signal x to help investors infer m: ρ_{mx}
    5. Investors, given x and ρ_{mx}, form their bond demand function

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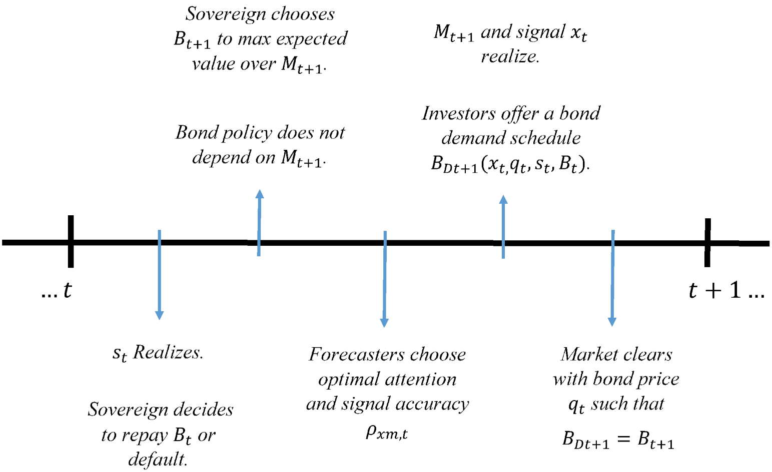
Model: Timing at t



Model: Sovereign's Problem (optional)

- Before m' (or m_{t+1}) realizes:

$$
\begin{aligned}
V(s,B,m) &= \max\{V_R(s,B), V_D(s,m)\} \\
V_R(s,B) &= \max_{B'} E_{m'}\{U\left[y(s) - B + q(B'|s,m')B'\right] + \beta E_{s'|s} V(s',B',m')\} \\
V_D(s,m) &= U[\tilde{y}(s)] + \beta E_{s',m'|s}[\theta V(s',0,1) + (1-\theta) V_D(s',1)]
\end{aligned}
$$

where $q(B'|s,m')$ is provided by investors' problem, and $\tilde{y}$ is penalized output for consumption.

- Growth process:

$y_t = e^{g_t} y_{t-1}$ where $s(y_t, g_t)$

$g_t = (1-\rho)\mu_g + \rho g_{t-1} + \sigma_\epsilon \epsilon_t$ where $\epsilon \sim N(0,1)$

- Default cost:

$\tilde{y}_t = y_t e^{-\psi + m_t}$

Model: Sovereign's Problem (optional)

After m' realizes:

- Default probability:

$$\mathcal{D}(m, B) = \{s \in S : V_R(s, B) < V_D(s, m)\},$$
$$\delta(m', s, B') = \int_{s' \in \mathcal{D}(m', B')} f(s, s')ds'$$

- Default decision tomorrow:

$$d(m', s', B') = \begin{cases} 1 & \text{if } V_R(s', B') < V_D(s', m') \\ 0 & \text{if } V_R(s', B') \geq V_D(s', m') \end{cases}$$

Model: Forecasters' Problem

- Optimal attention/signal accuracy before m' realizes:

$$\min_{\rho_{mx}} \quad E_x E_{s',m'|s,x}[d' - E_{s',m'|s}(d')]^2 + \kappa \mathcal{I}(\rho_{mx})$$

$$s.t. \;\; \mathcal{I}(\rho_{mx}) = \frac{1}{2}\log_2\left(\frac{1}{1-\rho_{mx}^2}\right)$$

Model: Investors' Problem & Market Clearing

- Optimal Investment $|x(m')$, after m' realizes:

$$\max_{B'_D} \; E_{s',m'|s,x}\left[U(c')\right]$$

$$s.t. \;\; c' = [\bar{w} - qB'_D](1+r) + [1 - d(m', s', B')]B'_D$$

$$where \;\; U(c) = \frac{c^{1-\gamma}}{1-\gamma}$$

- Market Clearing, after m' realizes:
  Bond market clears with the price $q(s, m', B')$ such that $B'_D = B'$

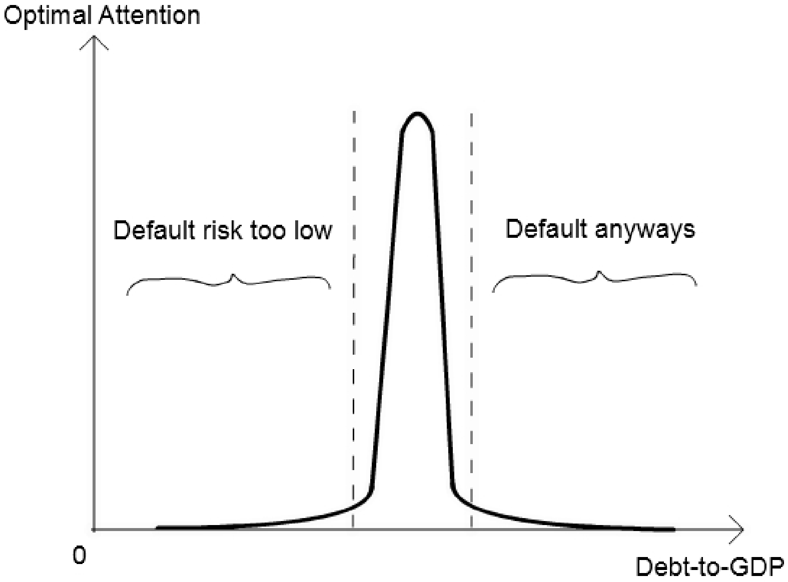
Model: Proposition (optional)

Proposition

When $\sigma_m = 0$, the model becomes that of Aguiar et al (2016) with permanent shocks and short-term debt.

- Nest standard sovereign default model, produce consistent results:
  1. High growth $\rightarrow$ High borrowing/low spreads
  2. Countercyclical net exports
  3. Default: Series of good shocks followed by surprise bad shock

New Mechanism



New Mechanism

- Endogenous cyclical variations in spread volatility:

  At crisis times, bond prices contain inferred info about m' realization

  $\rightarrow$ Spread volatility $\uparrow$ in crises

Key Parametrization (optional)

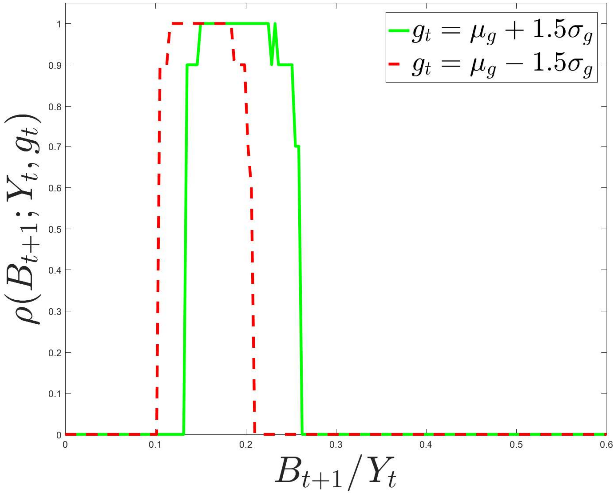
Table: Parameterization

Description	Value	Target
Parameter by Simulation:		**Matched collectively**
Sovereign discount factor	$\beta = 0.811$	Annual default frequency of 1.5%
Known Default cost	$\phi = 0.0226$	Ave Debt-to-output ratio 12.6%
Investor wealth	$\bar{w} = 2.5$	Ave spread 6.5%
Unobs shock std dev	$\sigma_m = 0.0153$	Ave spread std dev of 5.5%
Unit info cost	$\kappa = 0.000522$	Frac of Crisis Attn Periods 7.1%

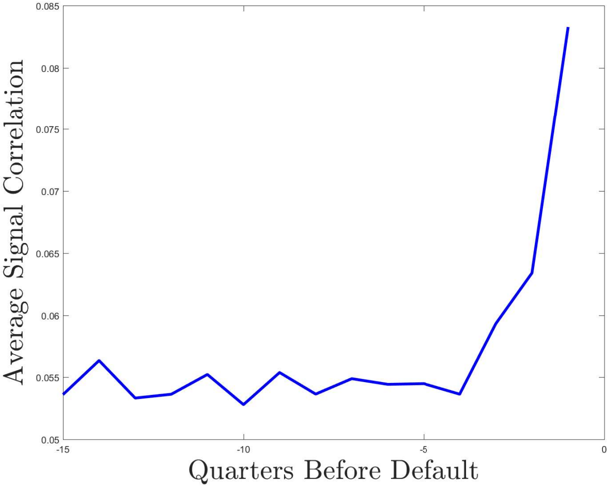
- Using Ukraine data from 2004-2014 at a quarterly frequency

Results:
Policy Functions & Dynamics

Information Acquisition Policy Functions: across g



Dynamics before Defaults: ρ_{mx}



Results:
Time-varying Volatility

Time-varying Volatility Measurement

Crisis Volatility Ratio (CVR)

- Define top 2.5% of the spread-change distribution as “jump" periods
- Compute the volatility 5 periods (i.e., quarters) before a jump event and 5 periods after (excluding the jump period itself)
- $CVR = \frac{1}{|\hat{T}|} \sum_{t \in \hat{T}} \frac{\hat{\sigma}_{t:t+5}}{\hat{\sigma}_{t-6:t-1}}$

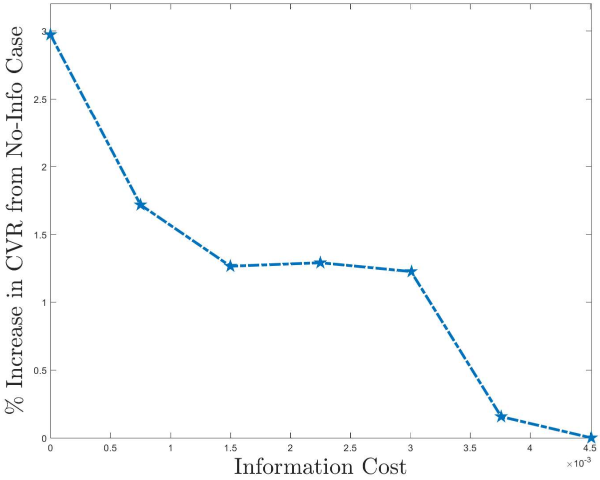
Time-varying Volatility

Time-varying volatility (CVR):

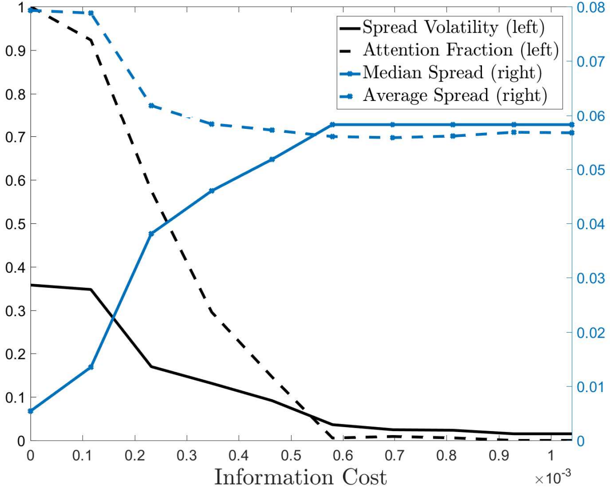
Table: Simulated statistics: the model and the data

Data (Ukraine)	Benchmark Model	$\kappa = \infty$	$\sigma_m = 0$
3.67	2.86	1.33	1.27

Time-Varying Volatility (optional)



Those Sensitive to κ Changes (optional)



Results:

Optimal Transparency

Transparency: Trade-offs

- How do investor information costs affect sovereign?

  1. Cheaper information $\implies$ Lower risk premium (esp. during crises)
  2. Cheaper information $\implies$ More volatile prices (esp. during crises)

- Model suggests optimum in middle, i.e., some opacity optimal

Transparency: Trade-offs

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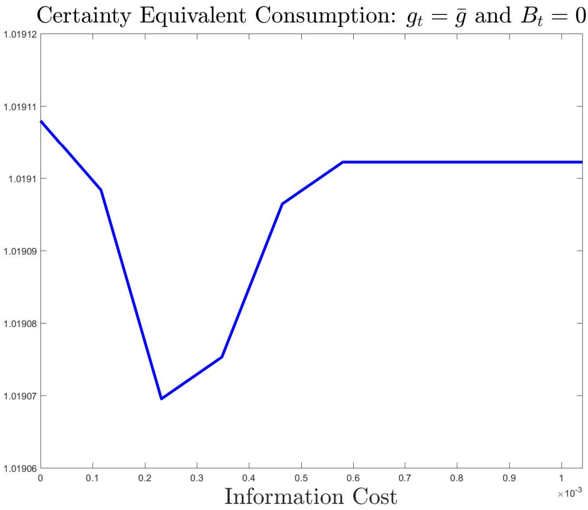
Transparency: Welfare Comparative Statics



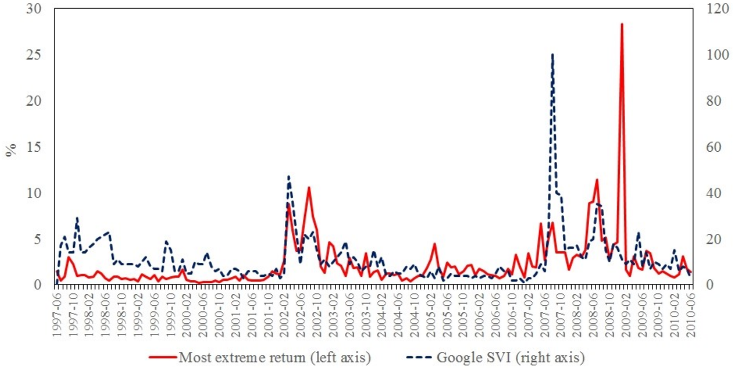
Conclusion

- Key contributions:
  - Explore the role of costly information for sovereign debt pricing, via forecasters/investors' attention allocation problem
  - Endogenize and amplify time-variation in sovereign spread volatility
- Main results:
  - Time-varying spread volatility
  - Transparency: Some opacity optimal
  - Time-varying spread composition: without considering endogenous info acquisition, default risk estimates can be underestimated during crises

APPENDIX

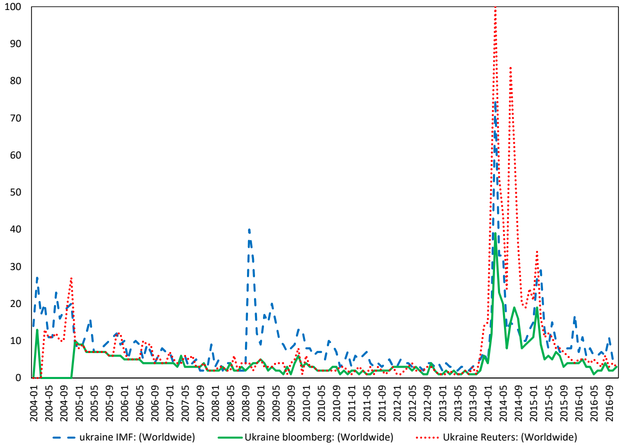
Motivation

Figure: Comparison of SVI and Extreme Returns



Motivation

Figure: Comparison of Benchmark Search Term to Alternate Search Terms



Motivation

Figure: Benchmark Search Language versus Most Common Alternatives

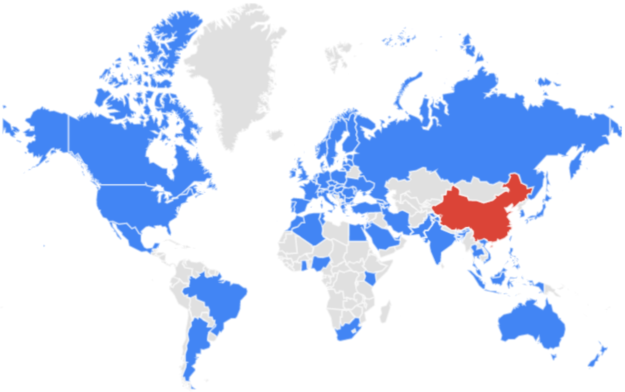
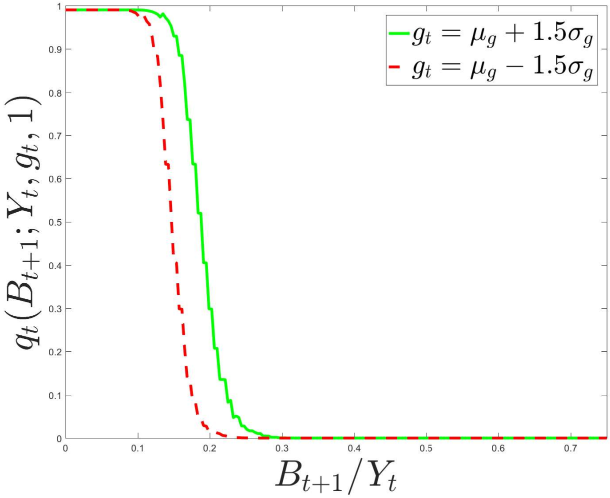


Figure: Blue: English (Benchmark), Yellow: Russian, Red: Chinese

Results

Figure: Equilibrium Bond Demand Functions



Results

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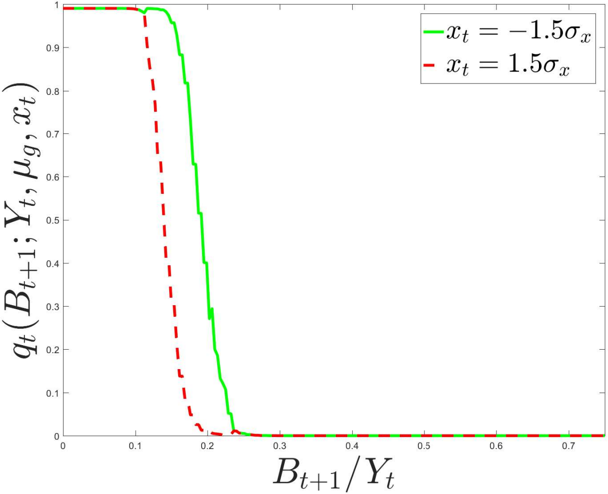

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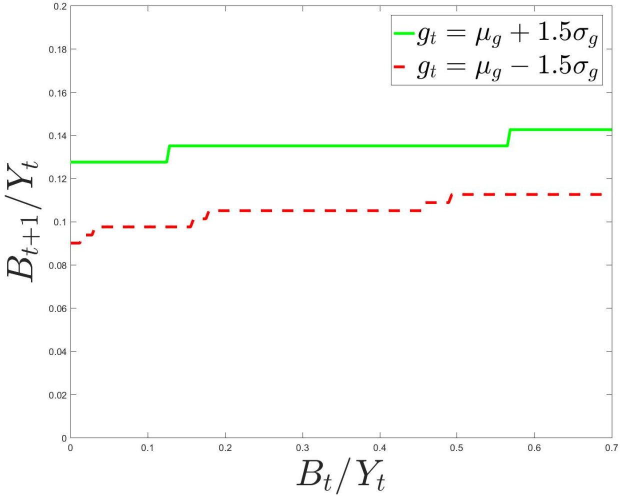
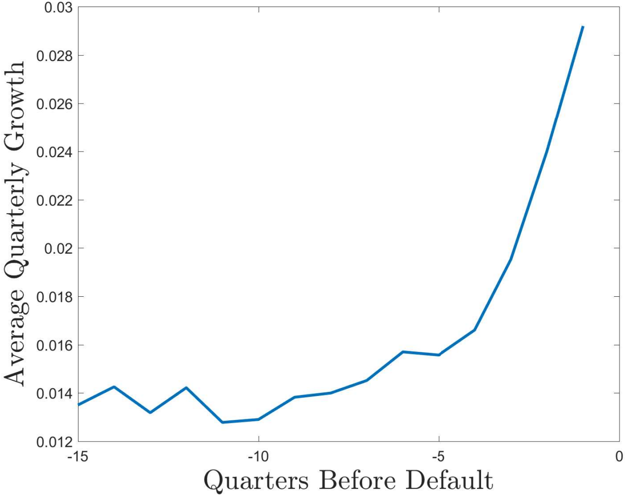


Results

Figure: Benchmark Behavior Around Default



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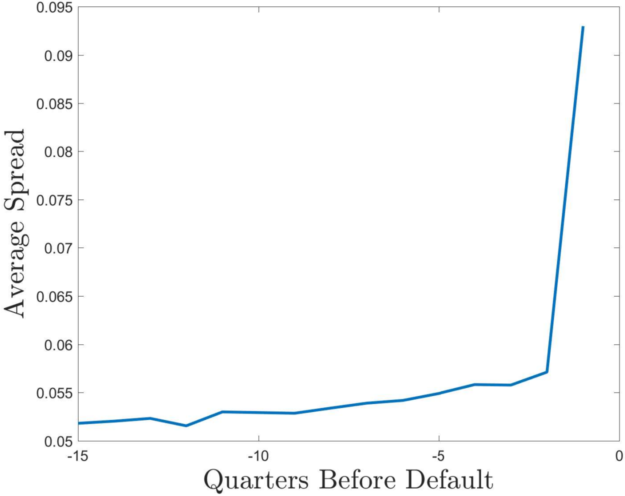

Risk Premium Difference: Baseline

- Spread=(1)Default risk + (2)Observed states' uncertainty premium + (3)Unobserved info uncertainty premium