Private Leverage and Sovereign Default

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Motivation

- Debt crisis in Southern European Countries
- Government spreads rose substantially
- Decline in economic activity, since 2007 GDP drops by 10-20%

Question:

- Did crisis originate in the government sector?
- Or is crisis due to aggregate shock with government as a veil?

Key Idea

- In cross section of firms response to shocks depend on characteristics
- If aggregate shock, same effect for all firms
- If government shock affects financial sector, high leverage firms exposed more
- Build a model of firms' heterogeneity and sovereign default
- Use micro data to identify source of crisis

What we do

- Develop a model of heterogenous firms with default risk
  - Financial conditions depend on government default risk
  - Subject to aggregate shock: disaster risk
- Use Italian firm micro data to calibrate model
  - Government default risk affects high leverage firms more
  - Disaster risk affects firms equally
  - Micro-level data good for identifying macro shocks
- Use calibrated model to interpret the recent crisis in Italy
  - Government default risk accounts for 2/3 of fluctuations
  - Disaster risk accounts for 1/3 of fluctuations

Literature

- Government crises affects aggregates through financial channel

  Neumeyer-Perri (2005), Uribe-Yue (2005), Bocola (2015)

- Aggregate shocks drive fluctuations and sovereign crisis

  Arellano (2008), Aguiar-Gopinath (2006), Mendoza-Yue (2012)

- Decomposition of shocks in Euro Crisis

  Philippon-Martin (2014)

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- Here we use micro data to identify shocks

  Gopinath, Kalemli-Ozcan, Karababounis, Villegas-Sanchez (2015)

Model

- Heterogeneous firms that borrow and default
- Government that borrows and defaults
- Firm financing costs depend on own default risk and gov. spread
- Households invest and provide labor
- Aggregate shocks: Disaster risk and government expenditure

Model: Firms

- Heterogeneous in productivity z_{it} and leverage λ_i
- Produce with capital and labor and pay fixed cost
- Choose k_{it} before shocks
- Finance λ_i fraction of capital with loan at price q_{it}

$$q_{it} b_{it} = \lambda_i k_{it}$$

- Firms profits are

$$\pi_{it} = z_{it}(k_{it}^{\alpha} \ell_{it}^{1-\alpha})^{\nu} - w_t \ell_{it} - r_t^k k_{it} - b_{it} - \xi + \lambda_i k_{it}$$

- Default $d_{it} = 1$ if profits negative
- If default firm exits, output used to pay for input costs, debt holders get zero

Model: Disaster Shock

- Firm productivity has idiosyncratic and aggregate component
- There are two regimes $s = 0, 1$
  - Regimes $s = 0$, probability $p_s = 1 - p_t$,

$$z_{it} = y_{it}$$

  - Regimes $s = 1$, probability $p_s = p_t$,

$$z_{it} = (1 - \mu_\theta) y_{it}$$

    where $0 < \mu_\theta < 1$ and

$$\ln y_{it} = \rho \ln y_{it-1} + \sigma^y \varepsilon_{it}$$

- Aggregate private shock: p_t probability of idiosyncratic disaster

Model: Government

- Government budget constraint

$$B_t^g = q_{t+1}^g B_{t+1}^g + S_t$$

- Default $d_t^g = 1$ if cannot roll over the debt

$$\max\{q_{t+1}^g B_{t+1}^g\} < B_t^g - S_t$$

where the surplus is

$$S_t = \tau_\ell w_t L_t + \tau_c C_t - G_t - T_t$$

- Aggregate public shock: G_t government expenditure shock

Model: Bond Price Functions

- Government price compensates for default loss

$$q_t^g = E\left[\frac{(1-d_t^g)}{1+r}\right]$$

- Government spread is

$$s_t^g = \frac{1}{q_t^g} - (1+r)$$

- Firm price compensates for default loss and depends on govt. spread

$$q_{it} = E\left[\frac{(1-d_{it})}{1+r}\right] - \beta s_t^g$$

- Implication arises in models where intermediaries have leverage constraints (Bocola 2015)

Model: Households

- Own firms
- Provide labor such that

$$U_{C,t}/U_{L,t} = w(1-\tau_L)/(1+\tau_C)$$

- Decide on investment such that

$$U_{C,t} = \beta E U_{C,t+1}(r^k_{t+1} + (1-\delta))$$

Analysis for Today

- Partial equilibrium model with endogenous firm default risk
- Exogenous government spread shock s_t^g
- Abstract from feedback from private sector to government sector
- Two shocks: Government spread and disaster risk

Firm Capital and Leverage

- Firm capital decreases with government spread and disaster risk
- Government spread increases effective marginal cost and firm default risk
  - Firms with high leverage affected more
- Disaster risk decreases expected marginal productivity and increases firm default risk
  - Effects similar across firms

Firm Problem

- Choose capital and default cutoff

$$v(y_{-1}) = \max_{k,\{y^*(s)\}} \sum_{s=0}^{1} p_s \int_{y^*(s)} \left[\pi(k, z(y,s)) + \frac{1}{1+r} v(y) \right] dF(y|y_{-1})$$

- Profits and financing requirement combined

$$\pi(k, z(y,s)) = M(z(y,s))k^{\theta} - r^k k - \xi - b(k) + \lambda k$$

- Financing requirement $b(k)$ from

$$\left[1 - \sum_s p_s F(y^*(s)) - \beta s^g \right] b = \lambda k$$

- Default cutoff $y^*(s)$, $\forall s$

$$\pi(k, z(y^*(s), s)) = 0$$

Characterization of Firm's problem

- Default cutoffs

$$M(z(y_s^*, s))k^\theta - r^k k - \xi = \lambda k \left(\frac{1}{1 - \sum_s p_s F(y_s^*) - \beta s^g} - 1 \right)$$

  - High k or high s^g increase default cutoff y_s^*

- Optimal capital

$$E[MPK] = r^k + \lambda \frac{\beta s^g}{1 - \beta s^g} + \underbrace{\sum_s p_s \left[\frac{\partial y_s^*}{\partial k} \frac{f(y_s^*)}{1 - F(y_s^*)} v(y_s^*) \right]}_{>0}$$

  - Default costly for firms: Lose future profits $v(y)$

Firm Problem and Government Spread

$$E[MPK] = r^k + \lambda \frac{\beta s^g}{1 - \beta s^g} + \sum_s p_s \left[\frac{\partial y_s^*}{\partial k} \frac{f(y_s^*)}{1 - F(y_s^*)} v(y_s^*) \right]$$

Capital is decreasing in s^g – more for high λ firms

- Absent default, s^g increase MC of investing and more for high λ

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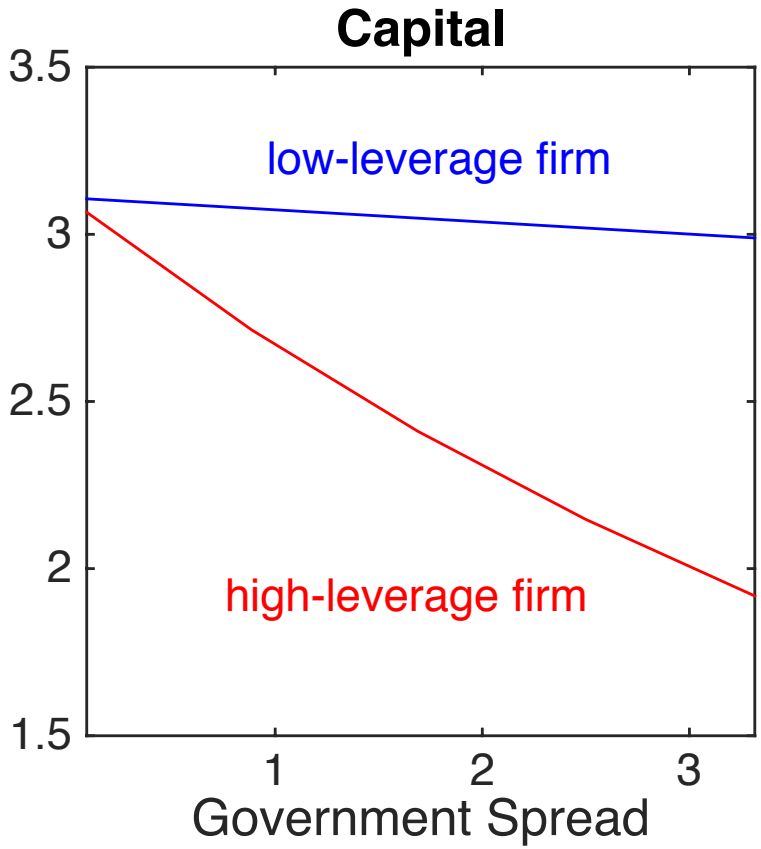
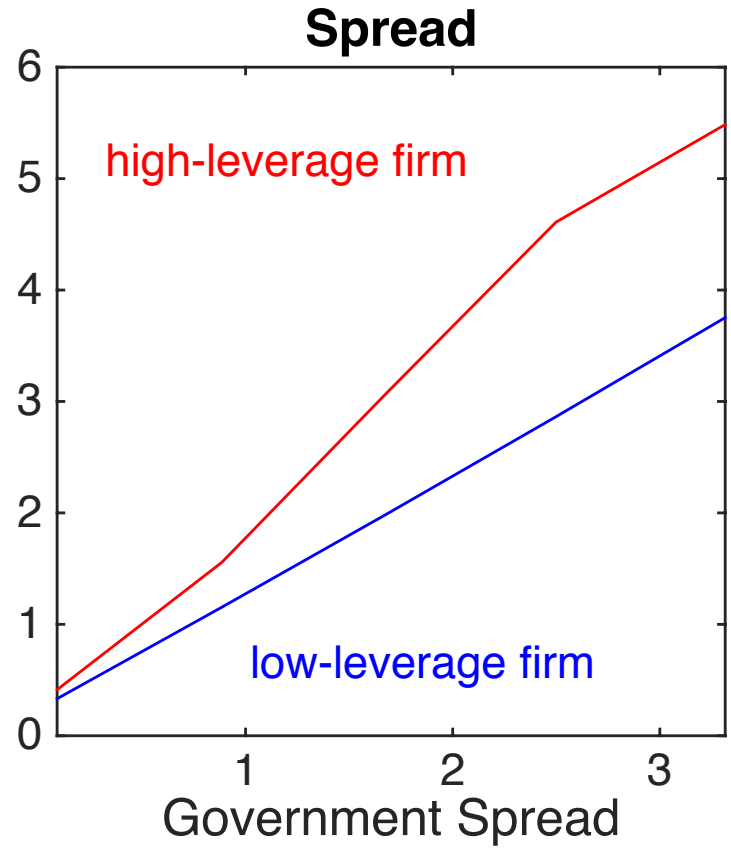
Capital is decreasing in s^g – more for high λ firms

- Absent default, s^g increase MC of investing and more for high λ
- With default, capital further decreases, more for high λ firms
  - Default incentive higher with high repayment due to high s^g
  - More for high λ firms: increase in loan is larger





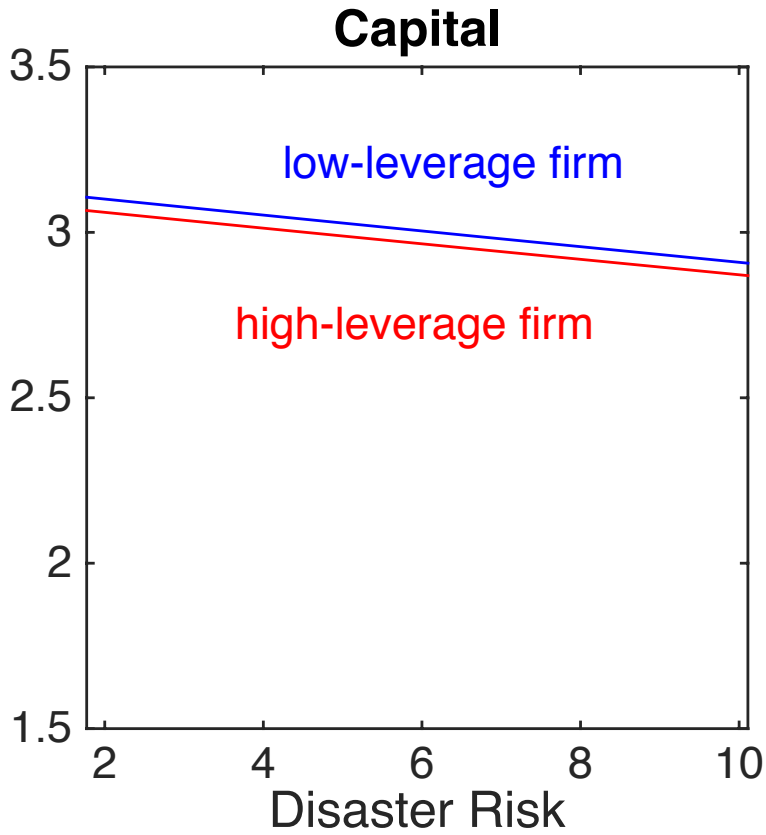
Capital decreases/firm spread increases with government spread

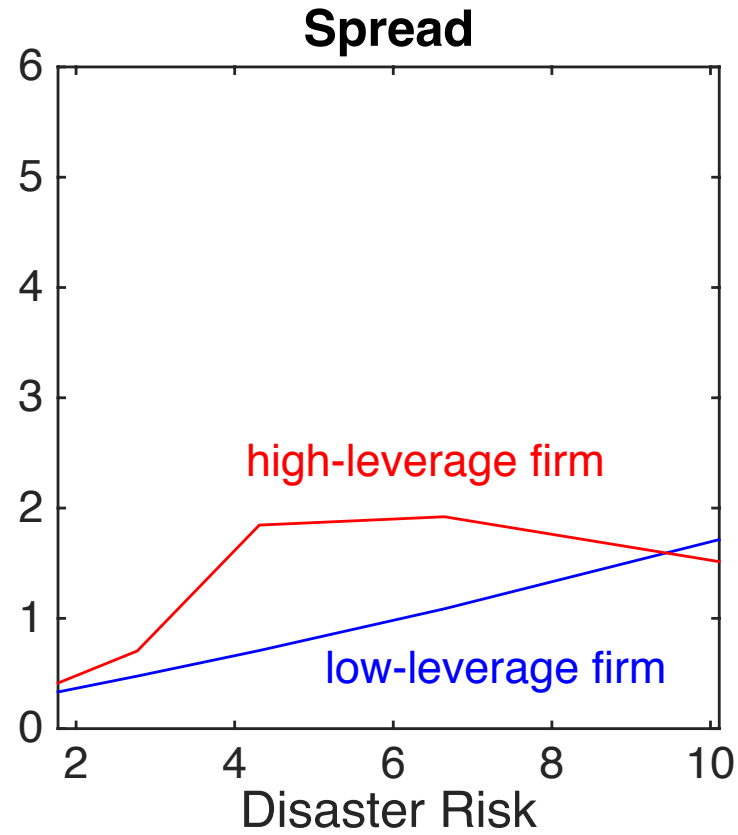
More so for high leverage firms

Firm Problem and Disaster Risk

$$E[MPK|p_s] = r^k + \lambda \frac{\beta s^g}{1-\beta s^g} + \sum_s p_s \left[\frac{\partial y_s^*}{\partial k} \frac{f(y_s^*)}{1-F(y_s^*)} v(y_s^*) \right]$$

- Disaster risk lowers expected productivity, capital decreases
- Default penalty $\sum_s p_s v(y_s)$ drops with higher disaster risk
- Not differentially for high λ





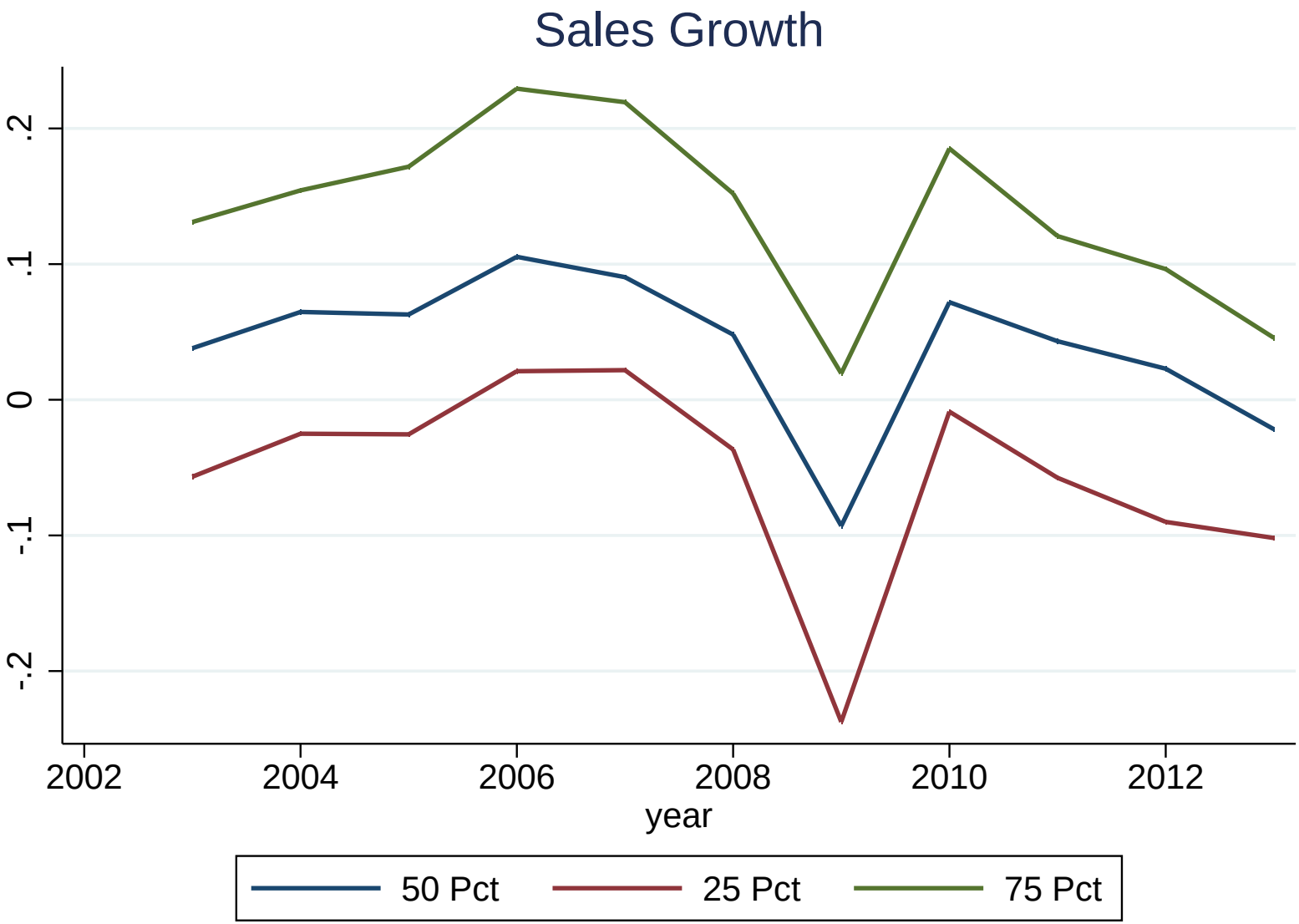
Capital decreases/firm spread increases with disaster risk

Effect similar across firms

Data

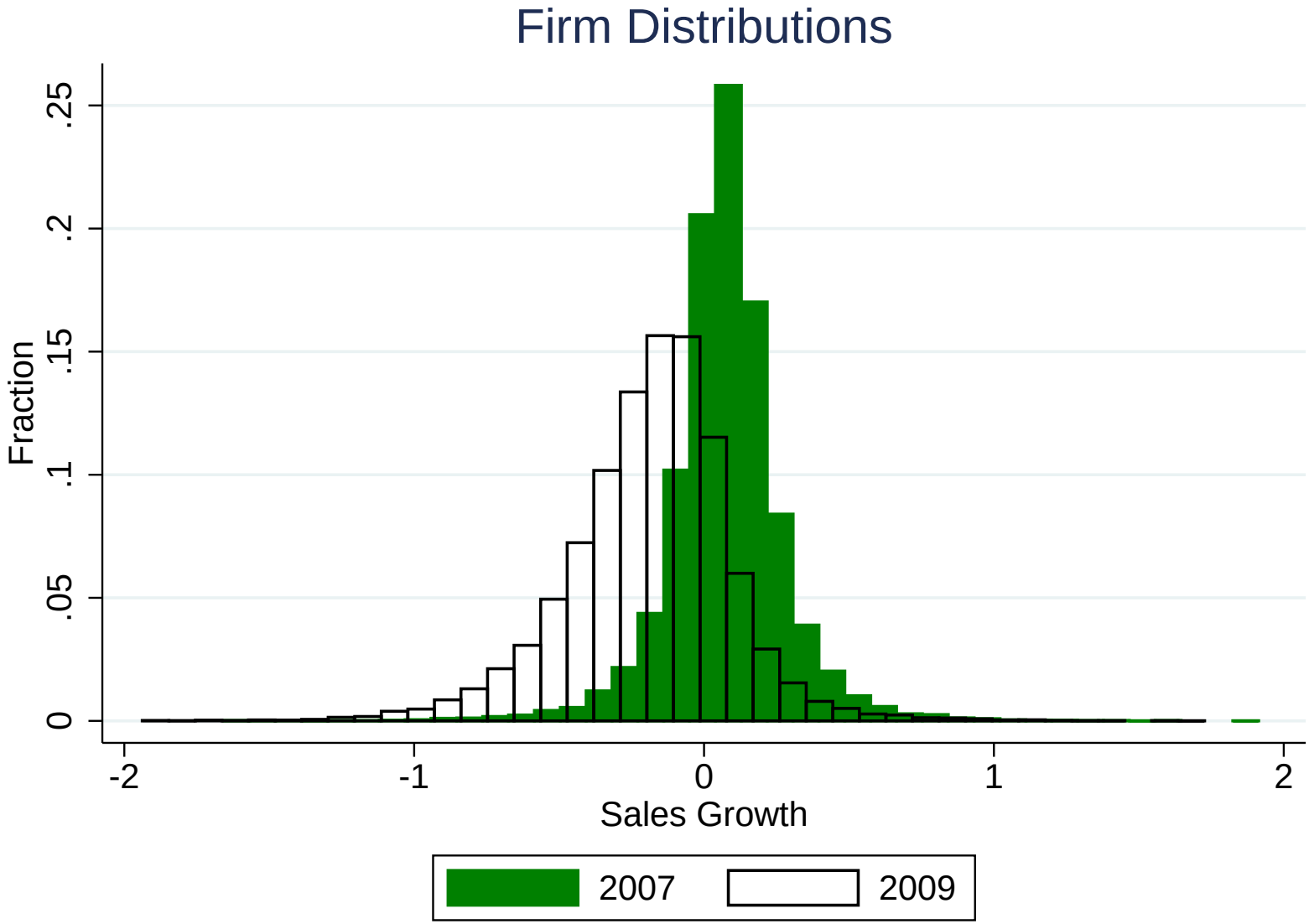
- Compustat Global from Italy (2000+ obs), 2002 to 2013
  - Sales growth: $(s_{it} - s_{it-1})/0.5(s_{it} + s_{it-1})$
  - Leverage: $\text{liabilities}_{it}/\text{assets}_{it}$
- Distribution of growth rates changes over time
  - Use to discipline disaster risk
- Find differential correlation of growth rates with government spread depending on leverage
  - Use to discipline effect of government spread

Firm growth



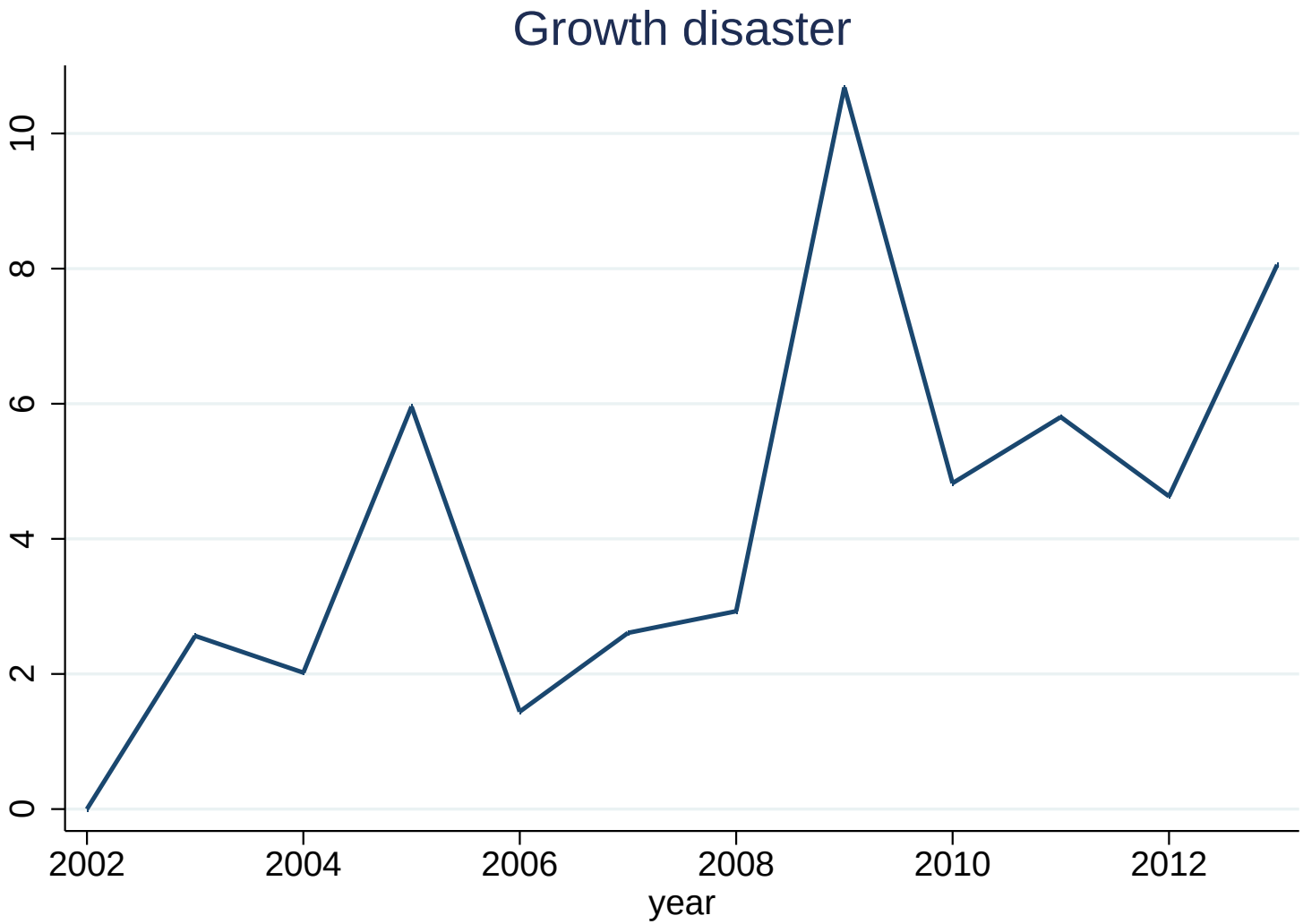
Growth declines in 2009 and 2012

Firm growth



Sales growth distribution fat left tail in 2009

Growth disaster



- gd_t: Fraction of firms with growth< -0.43 (=5 percentile panel)
- Proxy for disaster risk

Regression on Sales Growth

s_t^g	-1.8^{***}		2.7^{**}	0.5
$s_t^g \times \text{leverage}_{it}$			-4.4^{**}	-3.2^{*}
gd_t		-2.7^{***}	-2.1^{***}	-3.0^{***}
$gd_t \times \text{leverage}_{it}$			-0.7	0.5
controls	no	no	yes	yes
firm fixed effect	no	no	no	yes
Adjusted R^2	0.01	0.04	0.07	0.19

Growth in negatively correlated with government spread and disaster

Regression on Sales Growth

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Growth falls by 1.1% more with a 1% increase in s_t^g for firms with 0.25 higher leverage

Quantitative Analysis Strategy

- Use firm level moments to parameterize model
  - Leverage dispersion, growth dispersion
  - Effect of government spread on economy calibrated to get differential effect
  - Match interaction coefficient of $s_t^g \times leverage_{it}$ in similar regression
- Quantify the effects of aggregate shocks on GDP and corporate spreads in event study

Calibration

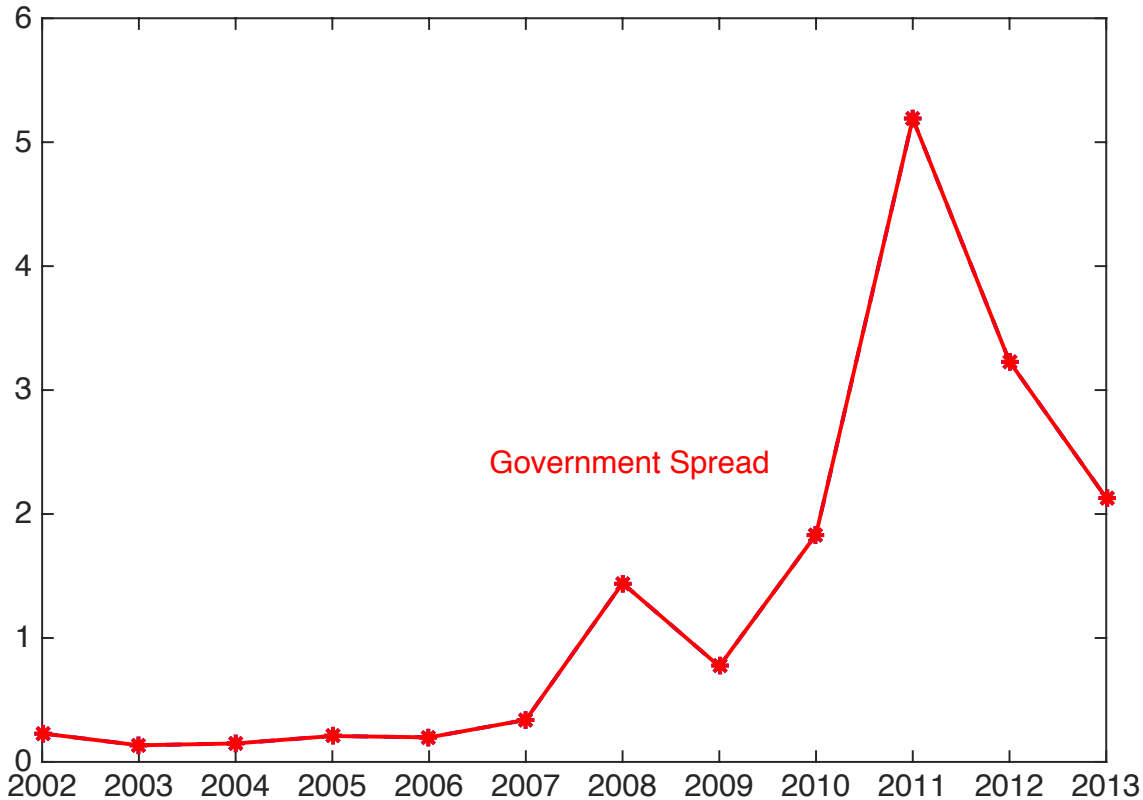
Spread process AR(1) to fit data, $\alpha = 0.33$, $\nu = 0.9$, $r = 2\%$, $\rho_y = 0.9$

Moment	Parameter	Data	Model
Std of growth disaster	σ^p	2.9	2.7
5 percentile growth	μ_θ	-0.43	-0.40
IQR sales growth	σ^y	0.20	0.28
IQR leverage	$\overline{\lambda}_{75,t} - \overline{\lambda}_{25,t}$	0.25	0.25
Int coeff$\times[\overline{\lambda}_{75,t} - \overline{\lambda}_{25,t}]$	β_g	-1.10	-1.10
Mean Leverage	$\overline{\lambda}_{25,t}$	0.52	0.02
Default rate	ξ	0.01	0.01

Aggregate implications

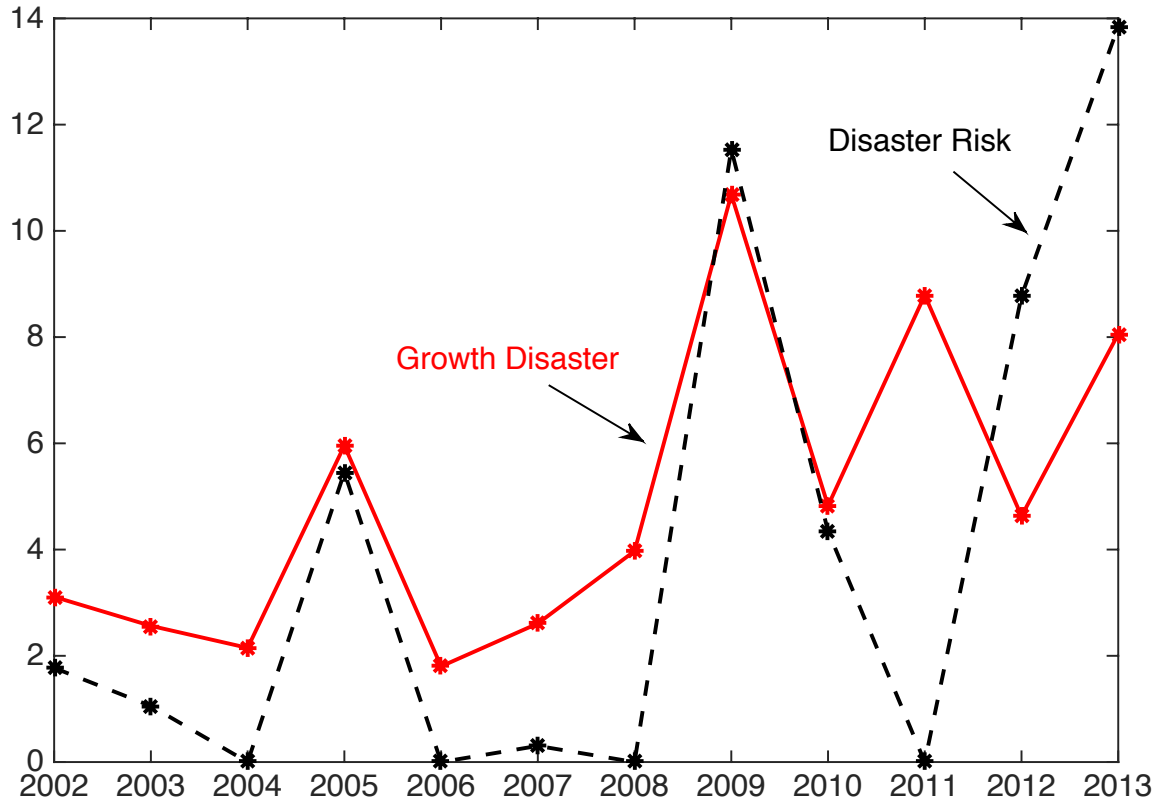
- With calibrated model, feed observed shocks
- Evaluate effect on GDP and corporate spreads
- Decompose contribution of government spread and disaster risk

Event: Spread shock



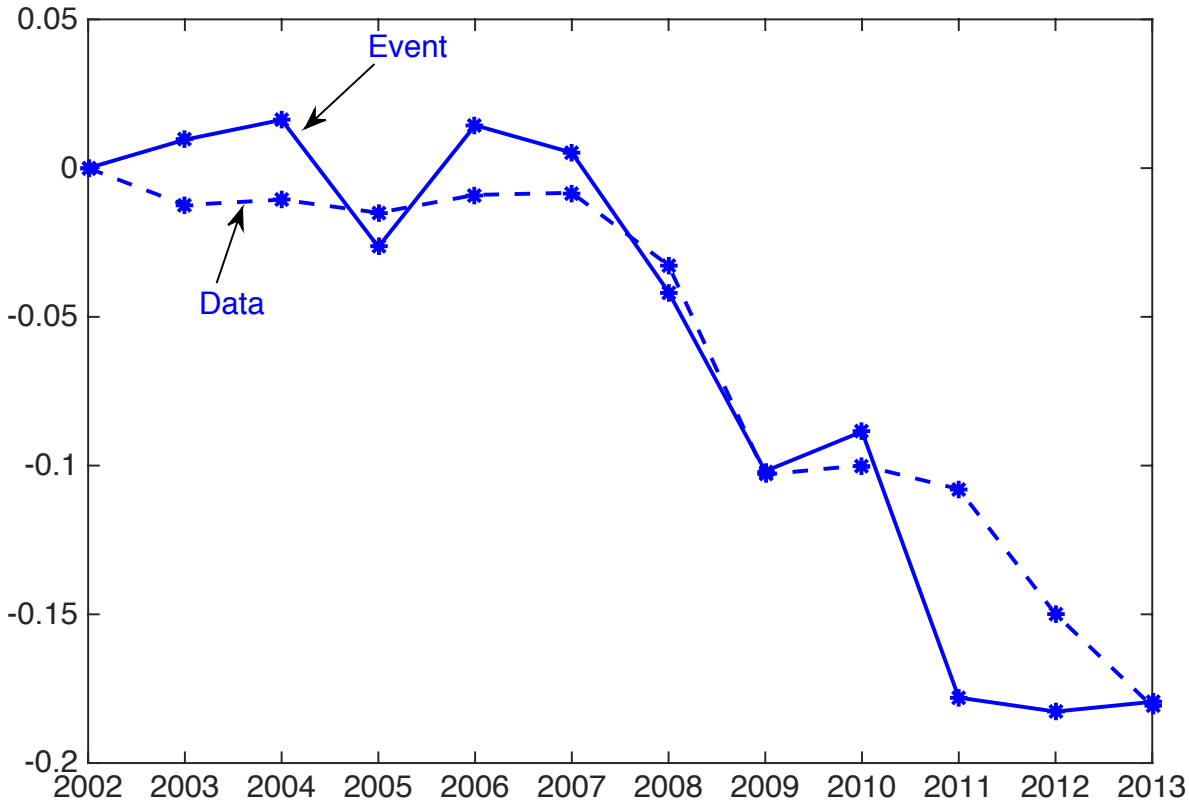
Feed spread shock s_t^g is as in data

Event: Disaster shock



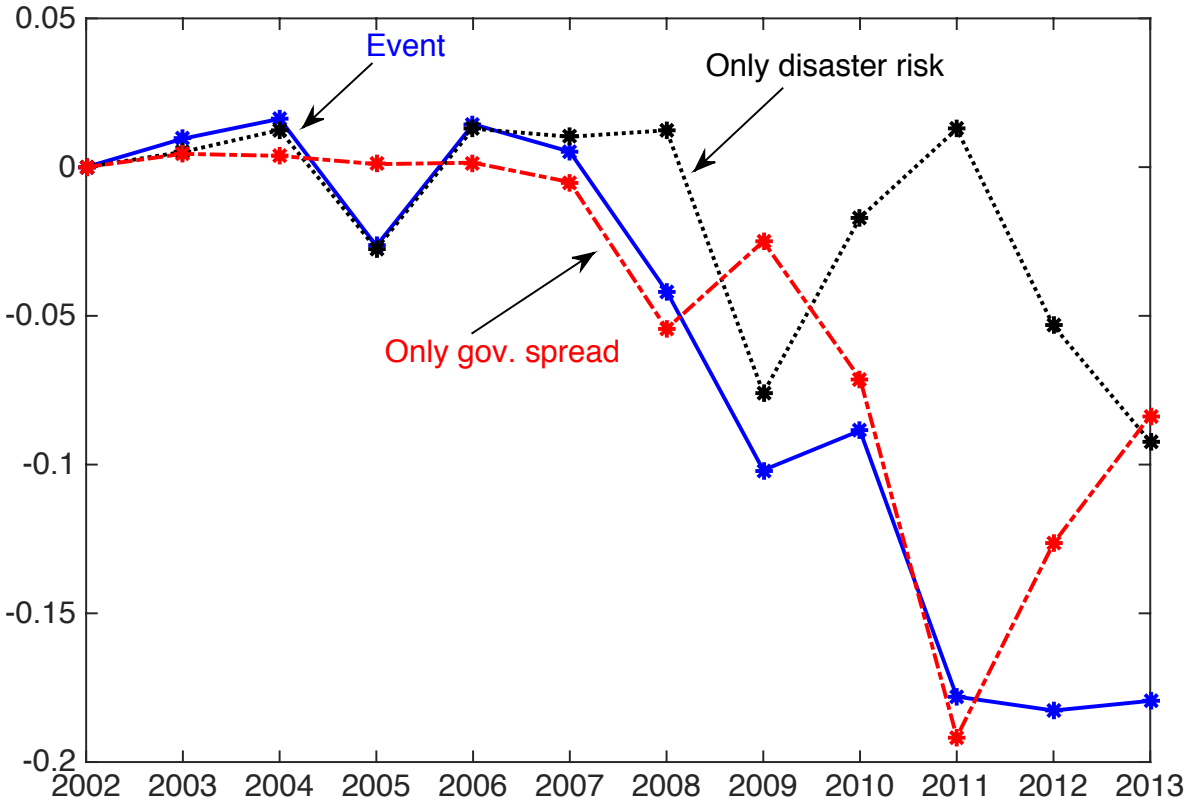
Disaster shock p_t to match time path of growth disaster

Event: GDP



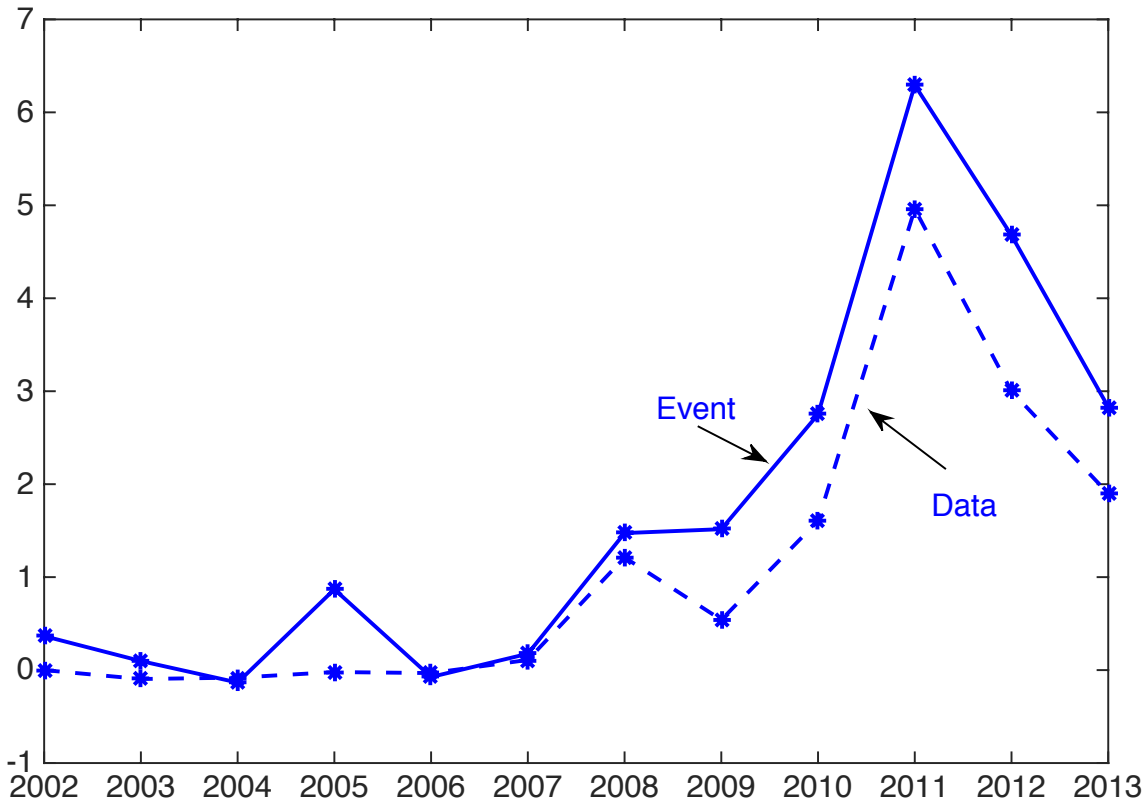
Model explains 90% of movement in GDP

Event: GDP Decomposition



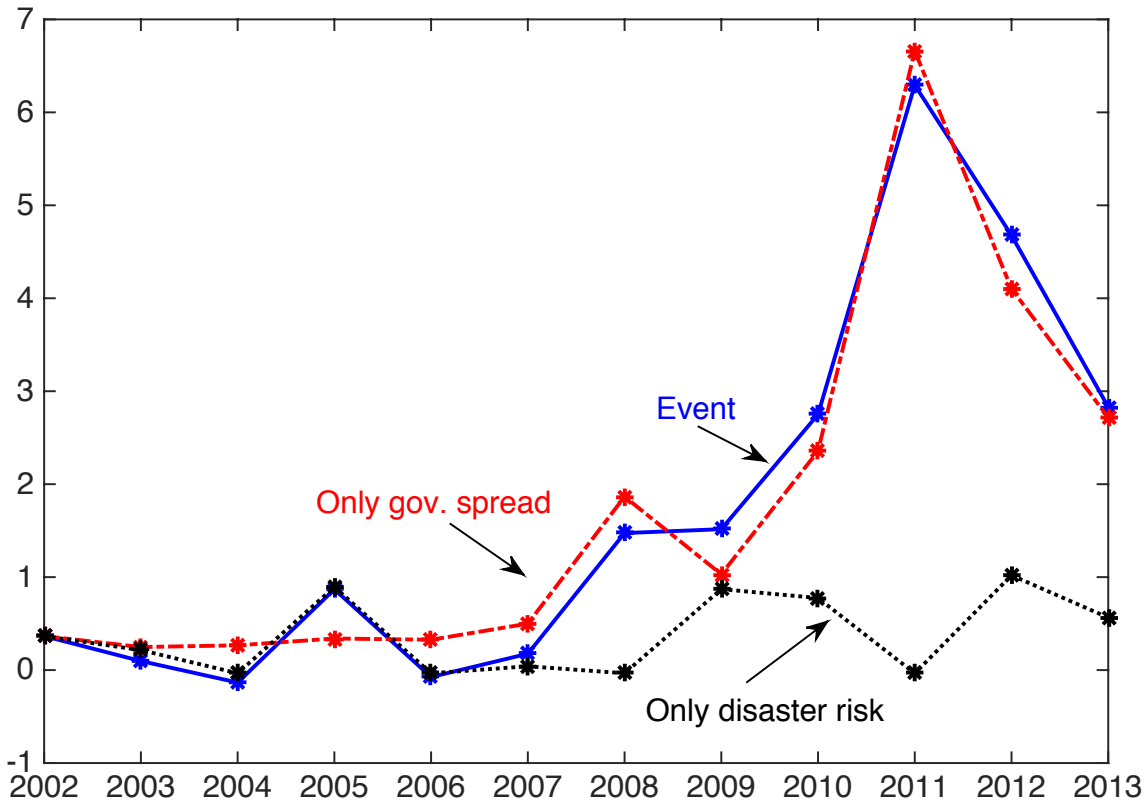
Government spread accounts for 83%; disaster risk accounts for 44%

Event: Firm Spreads



Model explains 90% of movement in corporate spreads

Event: Firm Spread Decomposition



Government spread accounts for 97%; disaster risk accounts for 5%

Ongoing work

Use Amadeus dataset (130000+ observations)

- Empirical findings robust: differential effect of government spread based on leverage
- Measure directly aggregate private shock from firms productivity evolution

Feedback from private sector to government

- Government spread responds to private shock
- Current results are upper bound on the role of public shocks
- Rely more heavily on structure of model for decomposition of shock contribution

Conclusion

- Use model of heterogeneous firms and micro data to measure effects of government crisis on private sector
- Government crisis accounts for large portion of decline in GDP