Identifying Firm-Level Financial Frictions Using Sign Restrictions.

Andrea Caggese*, Geert Mesters**

*UPF, CREI, and Barcelona GSE; **UPF, Barcelona GSE

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Introduction

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  - Distort investment, innovation, and export decisions. Cause misallocation of resources across firms, lower aggregate productivity.
  - Amplify business cycles.
  - Causes and consequences of financial crises.

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Paradox: firm financial frictions important in Macro and Corporate finance models, but measures of financial frictions in empirical applications are generally not model-based and not very informative (i.e. asset tangibility, external financial dependence, age, size).

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  - More difficult, in part because there are several different ways to model financial frictions (Higher interest rate? Quantity constraint? Asset based or earning based borrowing?)
- This paper proposes a new approach: identify ξ_t using model + panel data + a minimal set of identifying assumptions.
  - Advantage: identification consistent with broad range of financial friction models.

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   - Show that imposing very mild sign and inequality restrictions on parameters we can recover useful information on ξ (and θ and z).
   - Identification restrictions consistent with most types of financial frictions considered in the literature (includes asset based lending, earning based lending, and unsecured lending).
3. Use information on ξ to identify financially constrained firms, with an empirical application on Compustat data
   - Compare with narrative approach
   - Natural experiment based on the Great Recession.

The model

The model

Simple model with one flexible input.

- Results hold in a more general model with additional inputs subject to adjustment costs.
- A firm lives many period and produces using the following production function:

$$y_t = z_t l_t^{\alpha} \ , \tag{1}$$

With $0 < \alpha < 1$.

- l_t is the production input (call it labour)
- z_t is stochastic (productivity shock)

Timing

1. The firm observes the three shocks z_t, θ_t and ξ_t.
2. The firm decides l_t, b_t to maximise net present value of dividends subject to the budget constraint:

$$V_t(s_t, z_t, \xi_t, \theta_t) = \max_{l_t, b_t} (1 + \phi_t)\, div_t + \frac{1}{1+r} E_t \left[V_{t+1}(s_{t+1}, z_{t+1}, \xi_{t+1}, \theta_{t+1}) \right] \tag{2}$$

$$div_t + wl_t = s_t - \theta_t + \frac{b_t}{1+r} - c_t$$

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$$s_t = y_{t-1} - b_{t-1} \tag{3}$$

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   - θ_t is a liquidity shock not directly related to the production process.
   - ϕ is the shadow value of external finance
   - c_t is cost of financial frictions (next slide)
3. The firm produces $y_t = z_t l_t^{\alpha}$

Financial Frictions

- Budget constraint:

$$div_t + wl_t = s_t - \theta_t + \frac{b_t}{1+r} - c_t \tag{4}$$

- Dividends div_t cannot be negative, and the cost of debt is increased by an extra cost c_t which is increasing in leverage.

$$c_t = \left\{ \begin{array}{c} \xi_t b_t^\gamma \text{ if } b_t > 0 \\ 0 \text{ if } b_t \leq 0 \end{array} \right\} \tag{5}$$

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- With $\gamma > 1$. Results robust to adding capital and measuring leverage as $\frac{b_t}{k_t}$
- Results robust to a more general function:

$$c_t = \left\{ \begin{array}{c} \xi_t \left(b_t - p_t\right)^{\gamma} \text{ if } b_t > p_t \\ 0 \text{ if } b_t \leq p_t \end{array} \right\} \tag{6}$$

Where $p_t = \lambda_t^1 a_t + \lambda_t^2 y_t$ is the borrowing capacity of the firm.
With $0 < \lambda_t^1 < 1$ and $0 < \lambda_t^2 < 1$

The system

Log linearising the first order conditions and the production function we have:

$$\log b_t = C + \frac{1}{\gamma - 1}\log\psi_t - \frac{1}{\gamma - 1}\log\xi_t \tag{7}$$

$$\log n_t = C + \frac{1}{1-\alpha}\log z_t - \frac{1}{1-\alpha}\log\psi_t \tag{8}$$

$$\log y_t = \log z_t + \alpha\log l_t \tag{9}$$

Where ψ_t is the shadow value of external finance today relative to tomorrow:

$$\psi_t \equiv \frac{1+\phi_t}{1+E_t(\phi_{t+1})}$$

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the model implies that $\psi_t = \psi(\overset{-}{s}_t, \overset{+}{\theta}_t, \overset{+}{z}_t, \overset{+}{\xi}_t)$. Log linearising:

$$\log \psi_t = C - \pi_1 s_t + \pi_2 \log \xi_t + \pi_3 \log \theta_t + \pi_4 \log z_t \tag{10}$$

The system

Substituting $\log \psi_t$:

$$\log b_t = C - \frac{\pi_1}{\gamma - 1} s_t - \frac{1}{\gamma - 1}(1 - \pi_2) \log \xi_t + \frac{\pi_3}{\gamma - 1} \log \theta_t + \frac{\pi_4}{\gamma - 1} \log z_t \quad (11)$$

$$\log n_t = C + \frac{\pi_1}{1 - \alpha} s_t - \frac{\pi_2}{1 - \alpha} \log \xi_t - \frac{\pi_3}{1 - \alpha} \log \theta_t + \frac{1 - \pi_4}{1 - \alpha} \log z_t \quad (12)$$

$$\log y_t = C + \frac{\alpha}{1 - \alpha} \pi_1 s_t - \frac{\alpha \pi_2}{1 - \alpha} \log \xi_t - \frac{\alpha \pi_3}{1 - \alpha} \log \theta_t + \frac{1 - \alpha \pi_4}{1 - \alpha} \log z_t \quad (13)$$

- s_t is beginning of the period savings, so predetermined with respect to the 3 shocks.

System in matrix form

$$Y_t = c + D \log s_t + B\varepsilon_t \tag{14}$$

Where $Y = \begin{bmatrix} \log b_t \\ \log l_t \\ \log y_t \end{bmatrix}$ and $\varepsilon_t = \begin{bmatrix} \xi_t \\ \theta_t \\ z_t \end{bmatrix}$

Positive and decreasing marginal returns in l $(0 < \alpha < 1)$ and borrowing costs increasing in leverage $(\gamma > 1)$ imply the following restrictions on the B matrix:

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Positive and decreasing marginal returns in l $(0 < \alpha < 1)$ and borrowing costs increasing in leverage $(\gamma > 1)$ imply the following restrictions on the B matrix:

$$B = \begin{bmatrix} - & + & + \\ - & - & + \\ - & - & + \end{bmatrix}$$

$$\frac{B_{31}}{B_{21}} \in [0, 1]; \qquad \frac{B_{32}}{B_{22}} \in [0, 1]$$

- Restrictions very mild. Importantly, they are consistent with more general model and with shocks to either cost or quantity of credit.
- For empirical application we use $0.4 < \alpha < 0.8$
- Next, we discuss recovering B and ε_t using panel data and the above restrictions.

Structural VAR

In general, a large class of structural models can be written as SVAR

$$Y_t = c + DW_t + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + B\varepsilon_t \ ,$$

where

- W_t includes the pre-determined variables: (in the model: financial savings from previous period. In the empirical applications also fixed capital)

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where

- W_t includes the pre-determined variables: (in the model: financial savings from previous period. In the empirical applications also fixed capital)
- the lags $Y_{t-1}, \ldots, Y_{t-p}$ capture the dynamics
- the reduced form parameters are given by

$$\mu \equiv (\mathrm{vec}(\Phi)', \mathrm{vech}(\Sigma)')' \ , \qquad \Phi = (D, A_1, \ldots, A_p) \ , \qquad \Sigma = BB' \ .$$

- the sign restrictions on B together with estimates for μ allow to recover structural elements.

Structural VAR

- In principle,

$$Y_t = c + DW_t + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + B\varepsilon_t \ ,$$

  can be studied for any single firm

- but T is often short, leading to large uncertainty and uninformative estimates

- instead we rely on repeated cross-sections of firms for inference

Structural Panel VAR

We consider Structural Panel VAR (SPVAR)

$$Y_{i,t} = c_i + DW_{i,t} + A_1 Y_{i,t-1} + \ldots + A_p Y_{i,t-p} + B\varepsilon_{i,t}$$

where $i = 1, \ldots, N$ indexes firm.

Extend sign restriction based SVAR methods to short T panel data setting

- We estimate the reduced form parameters using Arellano-Bond.
- From the reduced form residuals $u_{i,t}$ and the sign restrictions we recover the sets of structural shocks

Reduced form inference

Let $u_{i,t} = B\varepsilon_{i,t}$ reduced form shocks.

The model in first differences is given by

$$\Delta Y_{i,t} = D\Delta W_{i,t} + A_1 \Delta Y_{i,t-1} + \ldots + A_p \Delta Y_{i,t-p} + \Delta u_{i,t} \ ,$$

Arrelano-Bond type moment conditions

$$\mathbb{E}(\Delta u_{i,t} Y'_{i,t-1-l}) = 0 \qquad \mathbb{E}(\Delta u_{i,t} W'_{i,t-l}) = 0$$

enable GMM inference

Reduced form inference

Define

$$\Delta Y_i = \begin{bmatrix} \Delta Y'_{i,1} \\ \vdots \\ \Delta Y'_{i,T} \end{bmatrix} \quad \Delta u_i = \begin{bmatrix} \Delta u'_{i,1} \\ \vdots \\ \Delta u'_{i,T} \end{bmatrix} \quad \Delta X_{i,t} = \begin{bmatrix} \Delta W_{i,t} \\ \Delta Y_{i,t-1} \\ \vdots \\ \Delta Y_{i,t-p} \end{bmatrix} \quad \Delta X_i = \begin{bmatrix} \Delta X'_{i,1} \\ \vdots \\ \Delta X'_{i,T} \end{bmatrix} .$$

Model for ΔY_i is given by

$$\Delta Y_i = (I_K \otimes \Delta X_i)\mathrm{vec}(\Phi) + \Delta u_i \ .$$

with $\Phi = (D, A_1, \ldots, A_p)$, and we can used instruments

$$Z_i = \begin{bmatrix} \tilde{Z}'_{i,1} & 0 & \ldots & 0 \\ 0 & \tilde{Z}'_{i,2} & 0 & \ldots \\ \ldots & \ldots & \ldots & \ldots \\ 0 & 0 & \ldots & \tilde{Z}'_{i,T} \end{bmatrix} = \begin{bmatrix} Z'_{i,1} \\ Z'_{i,1} \\ \vdots \\ Z'_{i,T} \end{bmatrix}$$

where $\tilde{Z}_{i,t} = (W'_{i,-p+1}, \ldots W'_{i,t-1}, Y'_{i,-p}, \ldots Y'_{i,t-2})'$

Reduced form inference

The GMM estimator for $\phi = \text{vec}(\Phi)$ becomes

$$\hat{\phi} = \text{vec}\left\{ \left[S'_{ZX} S_{ZZ}^{-1} S_{ZX} \right]^{-1} S'_{ZX} S_{ZZ}^{-1} S_{ZY} \right\}$$

where $S_{ZX} = \frac{1}{N} \sum_{i=1}^{N} Z_i' \Delta X_i$, $S_{ZY} = \frac{1}{N} \sum_{i=1}^{N} Z_i' \Delta Y_i$ and $S_{ZZ} = \frac{1}{N} \sum_{i=1}^{N} Z_i' G Z_i$[1]

The reduced form variance matrix $\Sigma = BB'$ is estimated by

$$\widehat{\Sigma} = \frac{1}{NT} \sum_{t=1}^{T} \sum_{i=1}^{N} \hat{u}_{i,t} \hat{u}'_{i,t} \qquad \hat{u}_{i,t} = (y_{i,t} - y_{i,.}) - \widehat{\Phi}'(X_{i,t} - X_{i,.})$$

where $y_{i,.}$ and $X_{i,.}$ denote the time averages.

[1] with G a tri-diagonal matrix with two on the main diagonal and minus one of the first sub-diagonals

Asymptotic results reduced form

Summarize reduced form estimates

$$\hat{\mu} \equiv (\mathrm{vec}(\widehat{\Phi})', \mathrm{vech}(\widehat{\Sigma})')'$$

It can be shown that

- $\hat{\mu}$ is asymptotically normal for $N \to \infty$

$$\sqrt{N}(\hat{\mu} - \mu) \xrightarrow{d} N(0, \Omega) \ .$$

- There exists $\widehat{\Omega}$ such that

$$\widehat{\Omega} \xrightarrow{p} \Omega$$

- Key difference wrt SVAR: Ω is not block-diagonal

Recovering structural shocks

- We recover sets of structural shocks $\epsilon_{i,t}$

The lower and upper bounds are given by

$$\hat{\varepsilon}^{L}_{i,j,t} = \inf_{B \in \mathbb{R}^{K \times K}} B_j^{-1} \hat{u}_{i,t} \qquad s.t. \quad \widehat{\Sigma} = BB', \ B \in \mathcal{R}(\hat{\mu})$$

$$\hat{\varepsilon}^{U}_{i,j,t} = \sup_{B \in \mathbb{R}^{K \times K}} B_j^{-1} \hat{u}_{i,t} \qquad s.t. \quad \widehat{\Sigma} = BB', \ B \in \mathcal{R}(\hat{\mu}) \ ,$$

- Note any element in $[\hat{\varepsilon}^{L}_{i,j,t}, \hat{\varepsilon}^{U}_{i,j,t}]$ is equally likely

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- The identifying restrictions are decreasing marginal return to labour and borrowing costs increasing in leverage.
- The output are set estimates of productivity shock z, liquidity shock θ and financial frictions shock ξ
  $[\widehat{log\xi_{i,t}}^{LB}, \widehat{log\xi_{i,t}}^{UB}]$
  $[\widehat{log\theta_{i,t}}^{LB}, \widehat{log\theta_{i,t}}^{UB}]$
  $[\widehat{logz_{i,t}}^{LB}, \widehat{logz_{i,t}}^{UB}]$
- Additionally, we can estimate the latent shadow value of finance ψ.
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- Next steps:
  - use simulated data to show admissible interval provides relevant information on true shock.
  - use $[\widehat{log\xi_{i,t}}^{LB}, \widehat{log\xi_{i,t}}^{UB}]$ to identify financially constrained firms on empirical data. Compare with narrative methods, and use Great recession as natural experiment.

Model based Evidence

- Solve the structural model and simulate a panel of 10000 firms for 10 periods
- Compare relation between shocks (true and estimated) and observables.

Dependent Variable: $log(y_t)$

VARIABLES	(1) True Shock	(2) Median shock	(3) Lower bound shock	(4) Upper bound shock
$log(\xi_t)$	-0.0034	-0.0040	-0.0037	-0.0060
$log(\theta_t)$	-0.0004	-0.0028	-0.0038	-0.0020
$log(z_t)$	0.0486	0.0429	0.0431	0.0429
Constant	3.4684	3.4646	3.4652	3.4642
Observations	80,000	80,000	80,000	80,000
R-squared	0.9992	0.7826	0.7819	0.7846

Robust standard errors in parentheses

Dependent Variable: $log(debt_t)$

VARIABLES	(1) True Shock	(2) Median shock	(3) Lower bound shock	(4) Upper bound shock
$log(\xi_t)$	-0.0485	-0.0629	-0.0658	-0.0602
$log(\theta_t)$	0.0235	0.0202	0.0223	0.0304
$log(z_t)$	0.1091	0.1029	0.1059	0.1005
Constant	2.3092	2.3006	2.2922	2.3033
Observations	80,000	80,000	80,000	80,000
R-squared	0.8024	0.8013	0.7908	0.7741

Robust standard errors in parentheses

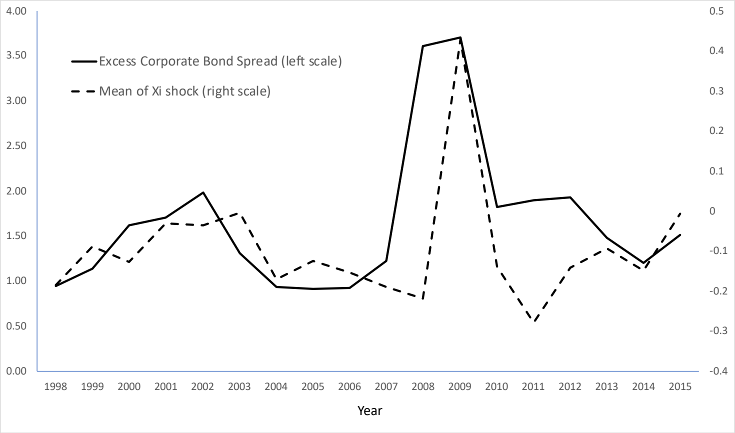
Dependent Variable: $log(debt_t)$

VARIABLES	(1) $log(\psi_t^{true})$	(2) $log(\psi_t^{true})$	(3) $log(\psi_t^{true})$	(4) $log(\psi_t^{true})$	(5) $log(\psi_t^{true})$
$log(\xi_t)$	0.3734	0.3731			
$log(\theta_t)$	0.2847		0.2843		
$log(z_t)$	0.2618			0.2595	
$log(\psi_t)$					0.6383
Constant	-1.4024	-1.4028	-1.4027	-1.4035	-1.4030
Observations	80,000	80,000	80,000	80,000	80,000
R-squared	0.8782	0.4221	0.2463	0.2072	0.6347
% Correct					83.1%

Empirical Evidence

1. Compare aggregate detrended $\widehat{log\xi_t}$ With Gilchrist and Zakrajsek (2012) excess bond premium.
2. Use financial shocks to construct dummy of likely financially constrained firms, and compare it to financial frictions estimated using narrative methods.
3. Great recession as a natural experiment.

1) Comparison with Excess Bond Premium



Average ξ shock and excess corporate bond spread from Gilchrist and Zakrajsek (2012)

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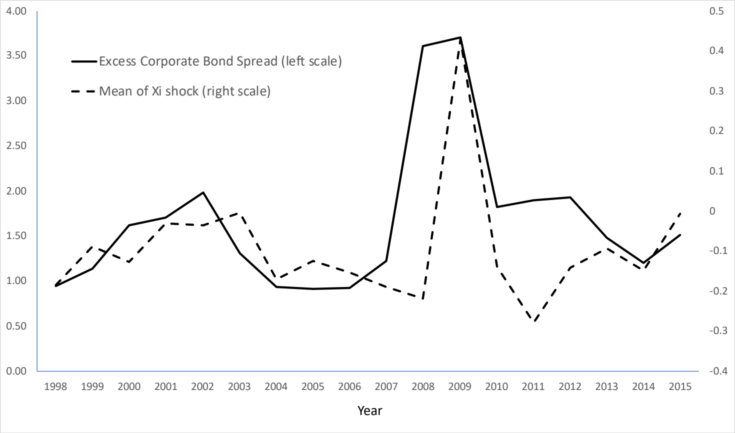

Average ξ shock and excess corporate bond spread from Gilchrist and Zakrajsek (2012)

Delayed effect in 2008-2009 perhaps because of firms using up credit lines.

2) Comparison with Financial frictions measure based on narrative approach

- We consider, as dependent variable, the *equitydelaycon* indicator proposed by Holberg and Maksimovic (2015).
- High value when firms indicate, in the "Capitalization and Liquidity" Subsection of the 10-K reports, delayed investment because of liquidity problems, which will be addressed by issuing equity.

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- High value when firms indicate, in the "Capitalization and Liquidity" Subsection of the 10-K reports, delayed investment because of liquidity problems, which will be addressed by issuing equity.
- Our main explanatory variable is *Dconstrained*, a dummy equal to one for the group of 25% firm-year observations with highest value of $\widehat{\xi_{i,t}}$, and zero otherwise.
- We consider alternative dummies based on $\widehat{\psi}$, $\widehat{\theta}$, $\widehat{z}$.
- control variables: 2-digit sector-year dummies; size (measured as number of employees), leverage, and labour productivity (measured as output divided by number of employees).

Dependent Variable: *equitydelaycon*

VARIABLES	(1) *Dconstr*. using θ	(2) *Dconstr*. using ξ	(3) *Dconstr*. using ψ	(4) *Dconstr*. using z
Dconstrained	0.012***	0.006***	0.007***	0.001
	(5.787)	(2.715)	(3.567)	(0.517)
log(fixedassets)	-0.009***	-0.009***	-0.009***	-0.009***
	(-7.070)	(-6.986)	(-7.151)	(-7.417)
leverage	0.000	0.001*	0.001*	0.001*
	(1.470)	(1.792)	(1.725)	(1.702)
labprod	-0.000***	-0.000***	-0.000***	-0.000***
	(-2.822)	(-3.000)	(-3.010)	(-2.976)
Dlarge	0.023***	0.024***	0.024***	0.024***
	(4.695)	(4.701)	(4.725)	(4.741)
Dhighlev	0.003	0.006	0.005	0.005
	(0.887)	(1.465)	(1.422)	(1.298)
Dhighprod	0.009*	0.009*	0.009*	0.009*
	(1.853)	(1.881)	(1.848)	(1.865)
Constant	-0.011	-0.010	-0.010	-0.008
	(-1.025)	(-0.881)	(-0.895)	(-0.758)
Observations	14,088	14,088	14,088	14,088
R-squared	0.104	0.102	0.102	0.101
Sector-Year FE	YES	YES	YES	YES

Robust t-statistics in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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- The coefficient of $D\hat{\xi}^{high}_{t} * Gr$ should be negative. Firms classified as constrained in $t = 2007$ should have reduced employment relative to unconstrained ones in the following year, more so than for $t < 2007$.

VARIABLES	(1) $\log(I_t)$	(2) $\log(I_t)$	(3) $\log(I_t)$	(4) $\log(I_t)$
$\log(I_{t-1})$	0.923***	0.923***	0.929***	0.927***
	(118.852)	(124.533)	(119.116)	(116.123)
$\log(I_{t-1}) * Gr$	-0.001	0.000	0.002	0.002
	(-0.419)	(0.084)	(0.528)	(0.612)
$D\hat{\xi}_{t-1}^{high}$	0.006	0.004	0.001	
	(1.359)	(0.960)	(0.119)	
$D\hat{\xi}_{t-1}^{high} * Gr$	-0.050***	-0.057***	-0.060***	
	(-3.092)	(-3.506)	(-3.296)	
$Small_{t-1}$		0.094	0.085	0.086
		(1.500)	(1.473)	(1.496)
$Small_{t-1} * Gr$		0.063*	0.076**	0.073*
		(1.762)	(2.063)	(1.919)
$Highlev_{t-1}$		-0.015**	-0.009	-0.009
		(-2.242)	(-1.223)	(-1.160)
$Highlev_{t-1} * Gr$		-0.011	-0.019	-0.019
		(-0.672)	(-0.967)	(-0.953)
$Lowprod_{t-1}$		-0.016	-0.003	-0.003
		(-1.435)	(-0.219)	(-0.271)
$Lowprod_{t-1} * Gr$		-0.015	0.010	0.003
		(-0.742)	(0.427)	(0.119)
$labp_{t-1}$			0.038**	0.038**
			(2.484)	(2.484)
$labp_{t-1} * GR$			0.027	0.023
			(1.572)	(1.372)
lev_{t-1}			-0.006	-0.009**
			(-1.641)	(-2.128)
$lev_{t-1} * GR$			0.004	0.005
			(0.576)	(0.718)
ξ_{t-1}				-0.004
				(-1.241)
$\xi_{t-1} * Gr$				-0.028**
				(-2.483)
Constant	0.105***	0.106***	-0.097	-0.093
	(7.895)	(7.680)	(-1.199)	(-1.159)
Observations	6,370	6,370	6,364	6,364
R-squared	0.894	0.894	0.895	0.895
Number of firm	439	439	439	439
Firm FE	YES	YES	YES	YES
Sector*Year FE	YES	YES	YES	YES

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Placebo experiment

VARIABLES	(1) 2008	(2) 2007	(3) 2006	(4) 2005	(5) 2004	(6) 2003	(7) 2002	(8) 2001
$D\hat{\xi}^{high}_{t-1}$	0.001	-0.004	-0.002	-0.002	-0.001	-0.002	-0.002	-0.005
	(0.119)	(-0.877)	(-0.505)	(-0.403)	(-0.286)	(-0.336)	(-0.485)	(-1.051)
$D\hat{\xi}^{high}_{t-1} * Gr$	-0.060***	0.015	-0.018	-0.001	0.005	0.002	0.018	0.021
	(-3.296)	(0.827)	(-1.177)	(-0.060)	(0.312)	(0.096)	(0.880)	(0.994)
Constant	-0.097	-0.119	-0.232***	-0.224***	-0.208***	-0.160**	-0.182***	-0.236***
	(-1.199)	(-1.522)	(-3.246)	(-3.045)	(-3.085)	(-2.561)	(-2.886)	(-3.378)
Observations	6,364	6,680	7,131	7,523	7,372	7,400	7,523	7,699
R-squared	0.895	0.899	0.899	0.896	0.897	0.886	0.887	0.885
Number of firm	439	462	493	519	509	514	524	535
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Sector*Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

VARIABLES	(1) 2008	(2) 2007	(3) 2006	(4) 2005	(5) 2004	(6) 2003	(7) 2002	(8) 2001
ξ_{t-1}	-0.004	-0.006*	-0.006*	-0.005	-0.003	0.000	-0.001	-0.002
	(-1.241)	(-1.700)	(-1.741)	(-1.535)	(-0.808)	(0.001)	(-0.165)	(-0.504)
$\xi_{t-1} * Gr$	-0.028**	0.007	-0.011	-0.015	-0.004	-0.009	0.007	0.001
	(-2.483)	(0.666)	(-1.089)	(-1.275)	(-0.377)	(-0.773)	(0.578)	(0.113)
Constant	-0.093	-0.116	-0.231***	-0.223***	-0.208***	-0.159**	-0.182***	-0.238***
	(-1.159)	(-1.495)	(-3.260)	(-3.044)	(-3.084)	(-2.552)	(-2.856)	(-3.388)
Observations	6,364	6,680	7,131	7,523	7,372	7,400	7,523	7,699
R-squared	0.895	0.899	0.899	0.896	0.897	0.886	0.887	0.885
Number of firm	439	462	493	519	509	514	524	535
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Sector*Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust t-statistics in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Conclusions

- New method to estimate panel data SVAR with sign and inequality restrictions.
- Apply to a new identification strategy to estimate financial frictions at the firm level.
- Balance sheet data + mild restrictions allow us to generate useful information on ξ (the financial frictions shocks).
  - Key property: consistent with wide range of financial imperfections.
- Can also recover latent shadow value of finance: $\psi_t = \psi(s_t, \theta_t, z_t, \xi_t)$. (but mapping more model dependent)