Corporate Borrowing, Investment, and Credit Policies during Large Crises

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Society for Economic Dynamics, Minneapolis, July 2021

The views expressed are those of the individual authors and do not necessarily reflect those of the Federal Reserve Bank of St. Louis, the Federal Reserve System, or of its Board of Governors.

Large Crises & Firms

- Large financial market disruptions hamper firms' ability to borrow and invest

- What type of credit/financial policies work best?

- Should depend on:

  1. Nature of underlying (aggregate) shock
  2. Distribution of firm financial characteristics

- Focus on two events: Great Financial Crisis and COVID-19 Recession

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This Paper: Empirics

What we do:

- Panel of maturity-matched corporate credit spreads (Gilchrist & Zakrajsek ’12)
- Match w/ firm-level financials to study response of firm financing conditions to crises

What we find:

- Different dynamics for firm financials:
  - GFC: debt, liquid assets ↓
  - COVID-19: debt, liquid assets ↑
- Similar initial increase in median spreads in the two events
- ... but shocks have different effects in the cross-section:
  - GFC: ↑ leverage ⇒ ↑ spreads, but no role for liquidity...
  - COVID-19: ↑ leverage ⇒ ↑ spreads, but ↑ liquidity ⇒ ↓ spreads

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- ... but shocks have different effects in the cross-section:
    - GFC: $\uparrow$ leverage $\Rightarrow$ $\uparrow$ spreads, but no role for liquidity...
    - COVID-19: $\uparrow$ leverage $\Rightarrow$ $\uparrow$ spreads, but $\uparrow$ liquidity $\Rightarrow$ $\downarrow$ spreads

This Paper: Model

What we do:

- Quantitative model of firm capital structure and investment
- Firms heterogeneous ex-ante, differ in leverage & liquidity
- Study effects of aggregate shocks: real (TFP), financial, liquidity
- Policy: QE (credit subsidies), credit guarantees, lump-sum transfers

What we find:

- Different aggregate shocks elicit different responses in the cross-section
  - Real+financial: investment comoves with debt/liq. assets
  - Liquidity shock: investment moves in opposite direction
  - Model-implied elasticities ⇒ GFC = real + financial shocks; ⇒ COVID-19 = liquidity shock
- Different policies are effective against different types of shocks
  - QE/credit subsidies effective against financial shocks
  - Transfers and credit guarantees effective against liquidity shocks
  - Cross-sectional information helps policymakers pick the most appropriate policy

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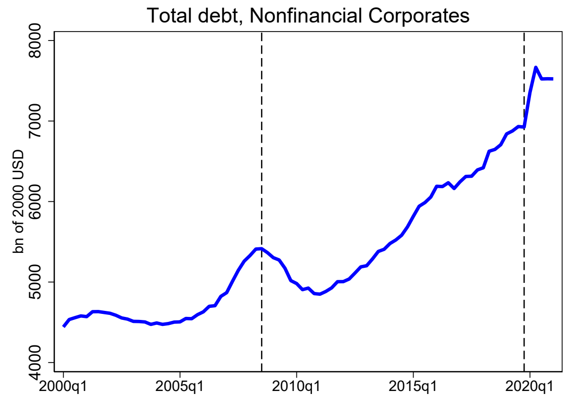
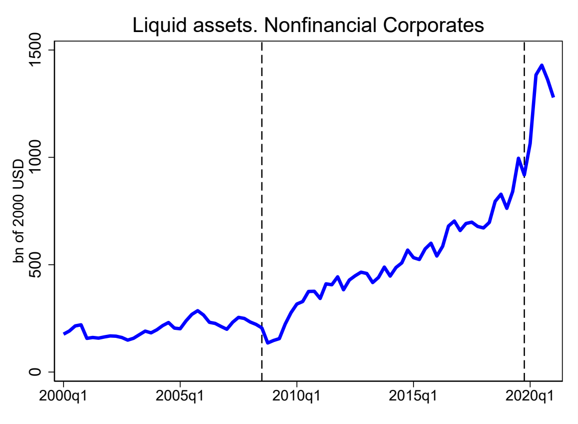
Literature

- **Role of firm heterogeneity in the response to shocks**: Kudlyak & Sanchez '17; Ottonello & Winberry '20; Jeenas '19; Tourré & Crouzet '21
- **Modeling of Firm Balance Sheets**: Begenau & Salomao '19
- **Credit Spreads during COVID-19**: Kargar et al. '20; Boyarchenko et al. '20; Gilchrist et al. '20
- **Firm heterogeneity during COVID-19**: Crouzet & Gourio '20; Elenev et al. '20

Liquidity and Debt during Large Crises





Source: Financial Accounts of the United States, FRB

- **GFC**: debt and liquid assets ↓
- **COVID-19**: debt and liquid assets ↑

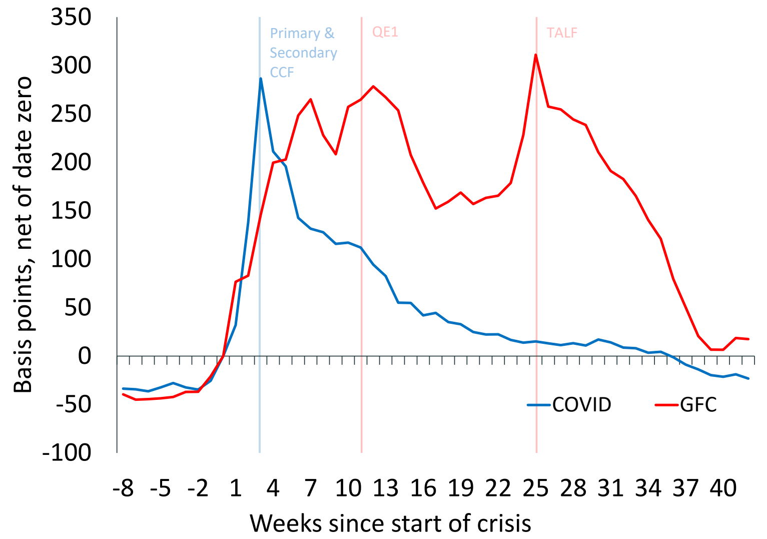
Measuring Firm Financing Conditions

- Measure of firm financing conditions: **maturity-matched corporate bond spreads**, following Gilchrist & Zakrajsek (2012)

$$s_{ift} = y_{ift} - y_{ift}^{RF}$$

- y_{ift}: secondary market yield of bond i, issued by firm f, on week t
- y_{ift}^{RF}: yield on synthetic security that replicates cash flows for bond i, but discounted at the risk-free yield curve at t
- $\sim$ 6 M bond-week observations, June 2002 to December 2020 ▸ details

Aggregate Spreads during Crises



Firm Level Characteristics: Liquidity and Leverage

- Is there any systematic relationship between firm financials and financing conditions?
- Focus on

$$\text{liq}_{f,t} = \frac{\text{Liquid Assets}_{f,t}}{\text{Assets}_{f,t}}, \quad \text{lev}_{f,t} = \frac{\text{Liabilities}_{f,t}}{\text{Assets}_{f,t}}$$

- Estimate:

$$\underbrace{s_{f,t}}_{\text{Firm outcome}} = \alpha_t + \gamma_f + \underbrace{\beta_{E(t)}\,\text{liq}_{f,t-r}}_{\text{liquid assets}} + \underbrace{\gamma_{E(t)}\,\text{lev}_{f,t-r}}_{\text{leverage}} + \Phi X_{f,t} + \varepsilon_{f,t}$$

- $s_{f,t}$: firm-level average credit spread (weighted)
- $E(t)$: whether quarter t is a "normal period", Great Recession or COVID-19 .
- $X_{f,t}$ includes other firm-time controls (size, lagged $s_{f,t}$)

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	$s_{f,t}$
Leverage	
Normal	196.584***
	(34.804)
GR	867.605***
	(131.905)
COVID	464.949***
	(90.324)
Liquidity	
Normal	-58.465***
	(21.736)
GR	34.458
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COVID	-430.430***
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N	43509
R2	0.75

- **Normal times**: $\uparrow lev, \downarrow liq \Rightarrow \uparrow s_{f,t}$
- **GR:** leverage has larger effects, liquidity has no effects
- **COVID:** liquidity has a larger effects
- $\uparrow 1\ \sigma\ lev \rightarrow s_{ft} \uparrow 143\ bps$ in GFC, $\uparrow 69\ bps$ in COVID
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- ▸ Investment ▸ Liquid Assets ▸ Debt

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Quantitative Model

Model of firm capital structure and investment ▸ Environment ▸ Frictions

- Issue defaultable debt: 1-period bonds, priced by risk-neutral investors (Eaton & Gersovitz '82)
- Hold liquid assets: firm subject to negative liquidity shocks (e.g., working capital)
- Can access costly intraperiod liquidity to satisfy liquidity shocks
- Costly equity issuance ▸ Firm problem

Heterogeneous Firms

- Ex-ante differences in motives for leverage, liquidity, and default risk
- Split US corporates into 4 groups: high/low leverage, high/low liquidity
- Model calibrated to match these four groups ▸ Calibration

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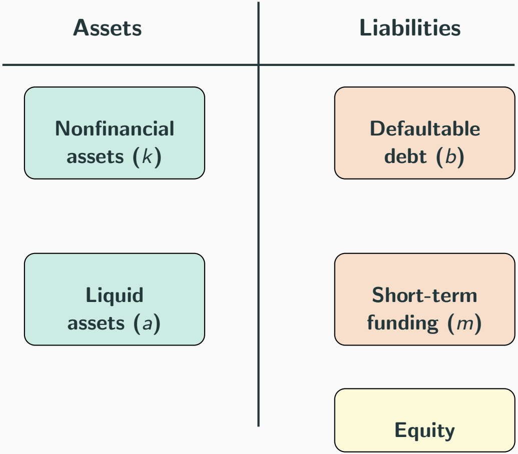
Firm's balance sheet



Assets

Nonfinancial assets (k)

Liquid assets (a)

Liabilities

Defaultable debt (b)

Short-term funding (m)

Equity

Quantitative Model, cont'd

Crises

- Large, unexpected, and transitory shocks
- Real, Financial, or Liquidity shocks ▸ Shock details
- Compute **aggregate** and **cross-sectional** moments and responses

Policies

- QE, Credit Guarantees, or Transfers ▸ Policy details
- **Aggregate** and **cross-sectional** "multipliers"

Quantitative Model, cont'd

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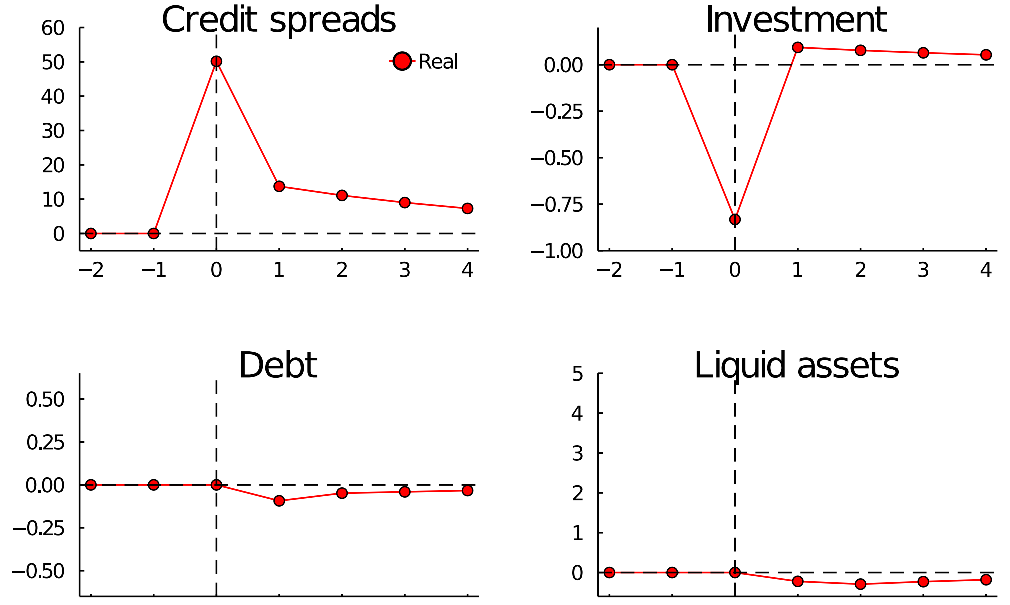
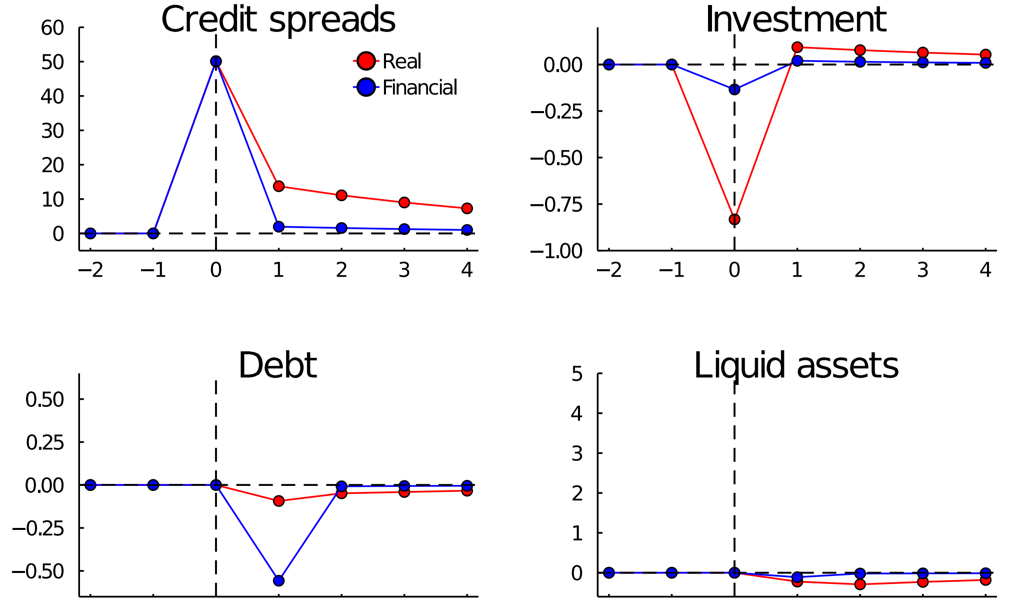
Aggregate Shock Responses

▸ Details



Aggregate Shock Responses

Details



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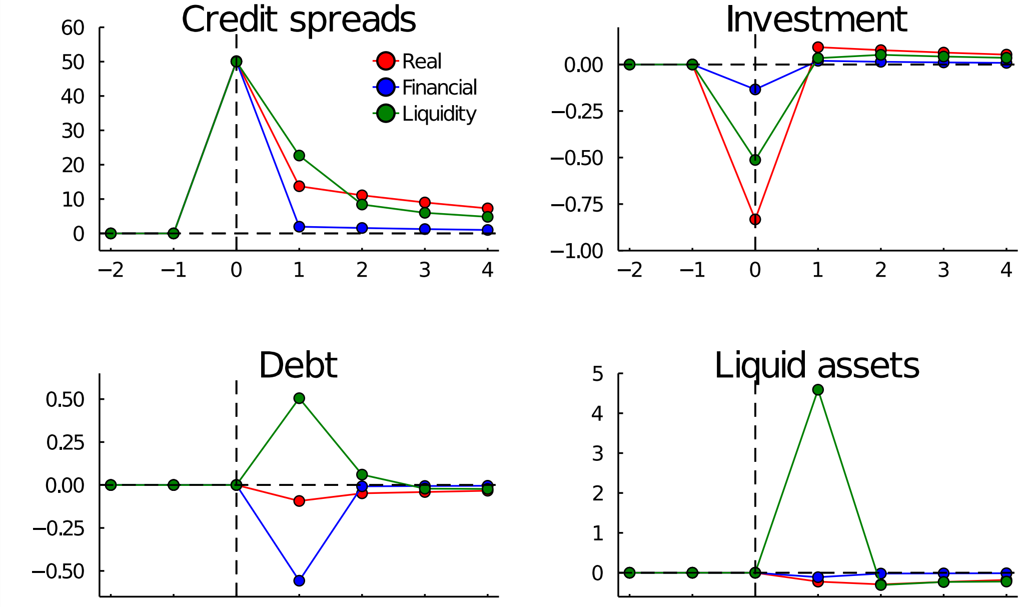
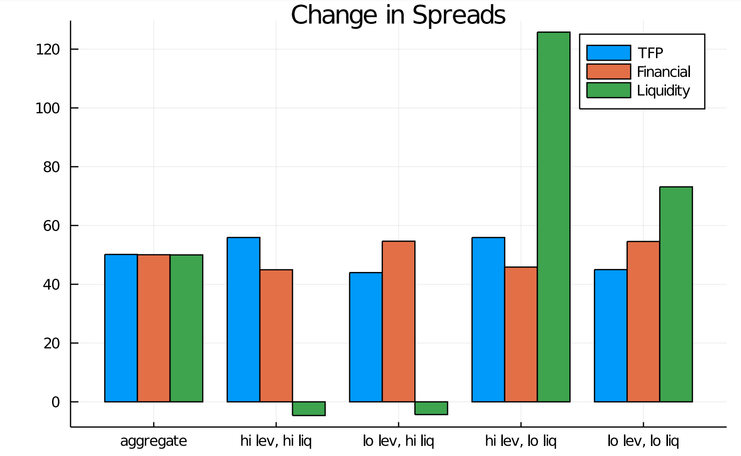


Cross-Sectional Effects: Credit Spreads

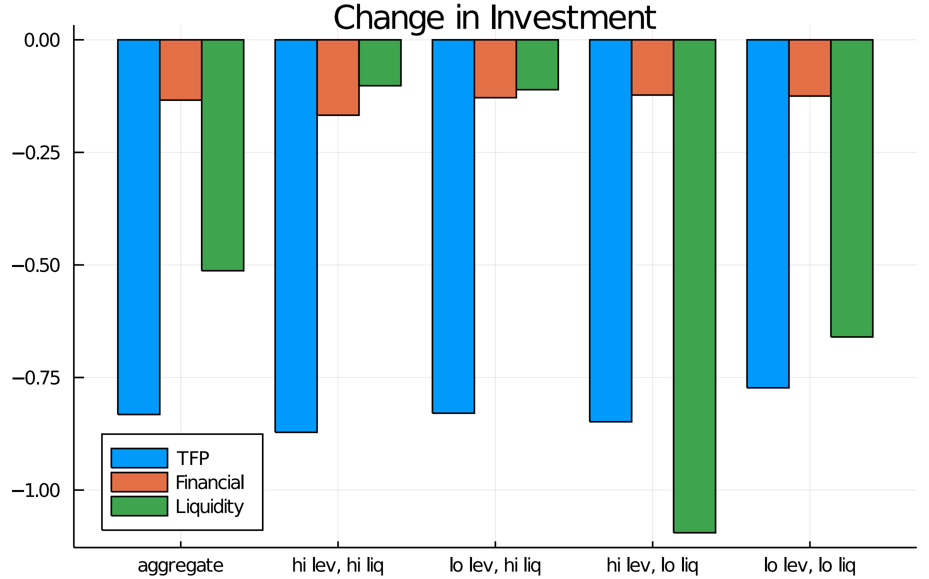


Effects are stronger for...

- **TFP**: high leverage
- **Financial**: low leverage
- **Liquidity**: low liquidity

▸ Empirical Evidence

Cross-Sectional Effects: Investment



Cross-Sectional Effects of Shocks

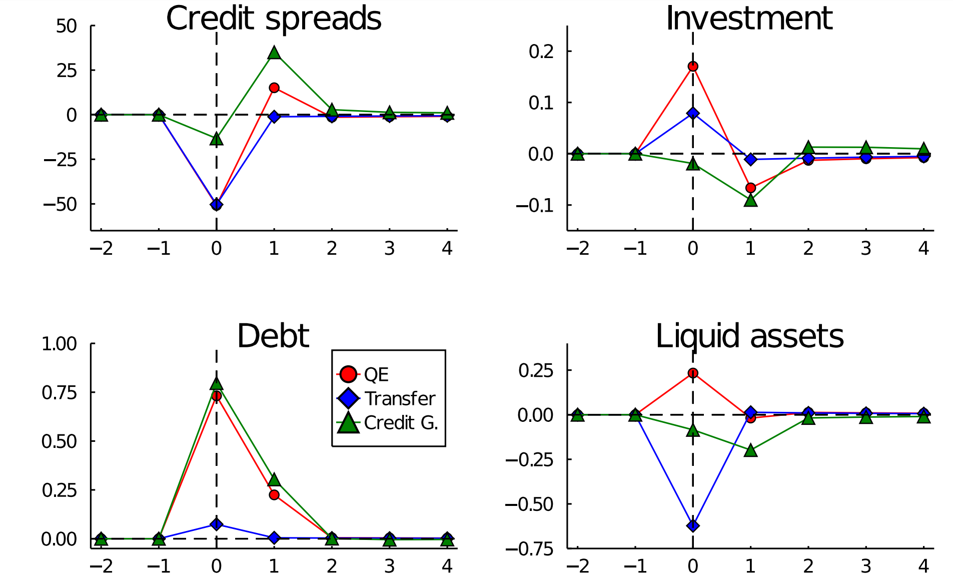
	Real	Financial	Liquidity
	Aggregate effects		
Spreads	50	50	50
Investment	-83	-13	-51
	Elasticities		
Spreads			
Liquidity	-5.14	-4.26	-1071.58
Leverage	46.13	-37.15	109.92
Investment			
Liquidity	-2.81	-1.73	54.86
Leverage	-1.62	-0.51	-6.15

Real: **larger** effect for firms with **high** leverage

Financial: smaller effect for firms with high leverage

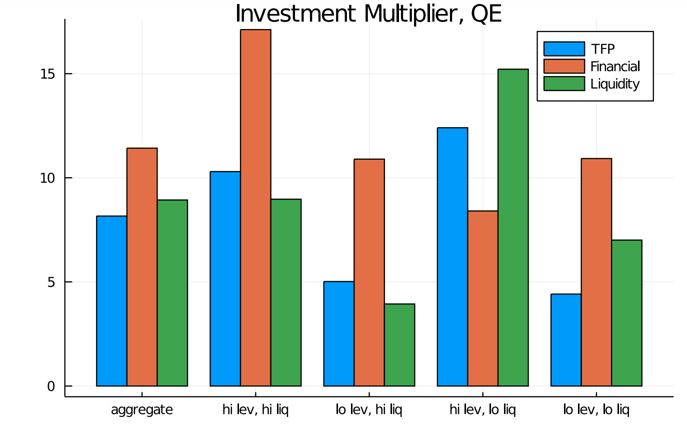
Liquidity: **smaller** effects for firms with **high** liquidity

Aggregate Effects of Policy: No (other) Shocks



Aggregate and cross-sectional Multipliers: QE

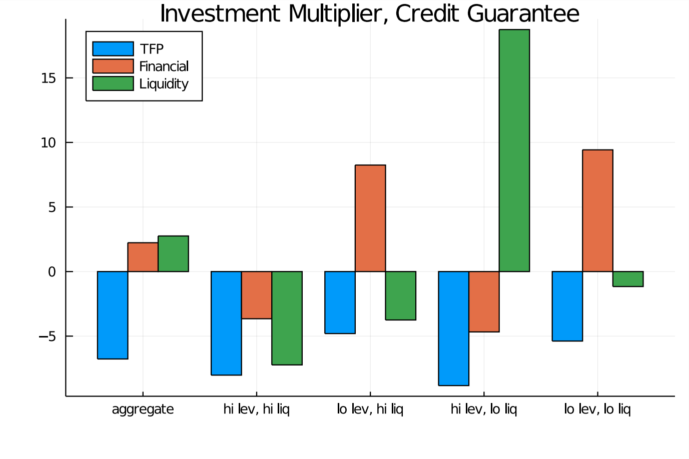
▸ Details



- QE effective overall, less so vs. real shocks
- Financial: + support to high lev. firms
- Liquidity: + support to low liq. firms

Aggregate and cross-sectional Multipliers: Credit Guarantees

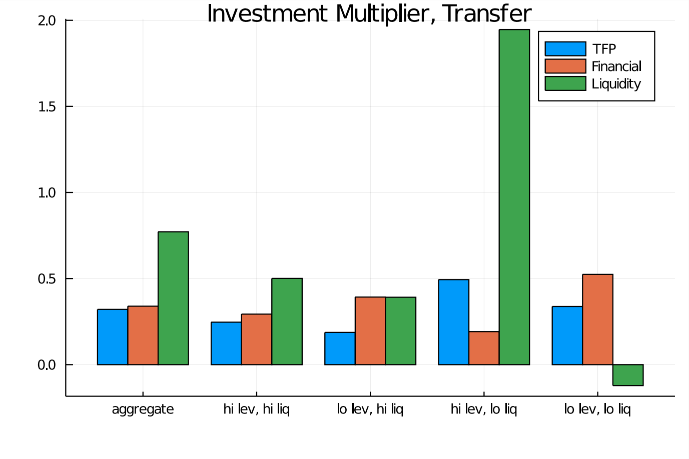
▸ Details



- Not effective vs. real shocks
- Financial: + support to low lev. firms
- Liquidity: + support to low liq. firms

Aggregate and cross-sectional Multipliers: Transfers

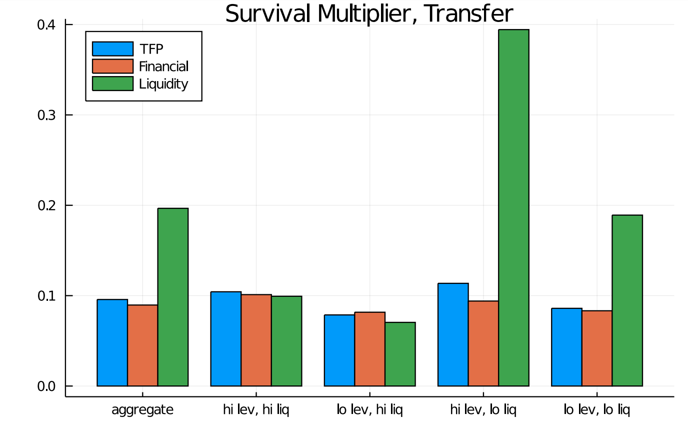
▸ Details



- More effective vs. liquidity shocks
- $+$ support to low liquidity firms
- Financial: $+$ support to low lev. firms

Survival Multipliers: Transfers

▸ Other Policies



- Transfers: only policy that *always* raises probability of survival
- Useful if policy objective is to prevent defaults

Conclusions

Empirical analysis of credit spreads during two large crises

- GFC looks like a solvency crisis, key variable: firm leverage
- COVID looks more like a liquidity crisis, key variable: firm liquid assets
- Debt/liquid assets move in opposite directions during both crises

Quantitative model calibrated to match firm distribution of liquidity and leverage

- Different shocks may have similar aggregate effects, but very different cross-sectional implications
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APPENDIX

Data

▸ back

- Bond yields sourced from TRACE, bond characteristics and payment schedules from Mergent FISD
- Sample selection: fixed- and zero-coupon bonds issued by US corporates, amount at issuance > $ 1 M, maturity at issuance between 1 and 30 years

Variable	Mean	SD	Min	Median	Max
Number of bonds per firm/week	5.52	19.50	1.00	2.00	828.00
Market value of issue ($ mil)	209.71	250.90	1.00	147.04	6422.77
Maturity at issue (years)	9.40	6.93	1.00	8.00	30.00
Coupon (pct.)	5.43	2.72	0.00	5.50	22.50
Credit Spread (basis points)	283.19	368.85	5.00	164.43	3499.99
Nominal yield (basis points)	606.08	472.96	17.55	523.54	10457.79
Number of observations	6,634,135				
Number of bonds	50,076				
Number of firms	3,646				
Callable (pct)	0.63				

Notes: Secondary market price of corporate bonds from the TRACE database. Credit spreads as in Gilchrist & Zakrajsek (2012). Restrict sample to US corporate bonds, fixed- and zero-coupon bonds, bonds with credit spreads between 5 and 3500

Investment Regressions

▸ back

	$\Delta log(k_{f,t})$
Leverage	
Normal	-4.011***
	(0.355)
GR	-3.451***
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COVID	-3.677***
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Liquidity	
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GR	7.087***
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R2	0.21

$$\Delta \log k_{f,t} = \alpha_t + \gamma_f + \beta_{E(t)} \text{liq}_{f,t-r} + \gamma_{E(t)} \text{lev}_{f,t-r} + \Phi X_{f,t} + \varepsilon_{f,t}$$

- **Normal times**: $\downarrow lev, \uparrow liq \Rightarrow \uparrow \Delta \log k_{f,t}$
- Coefficients similar across periods/events
- H_0 of equal coefficients across events not rejected at 1%

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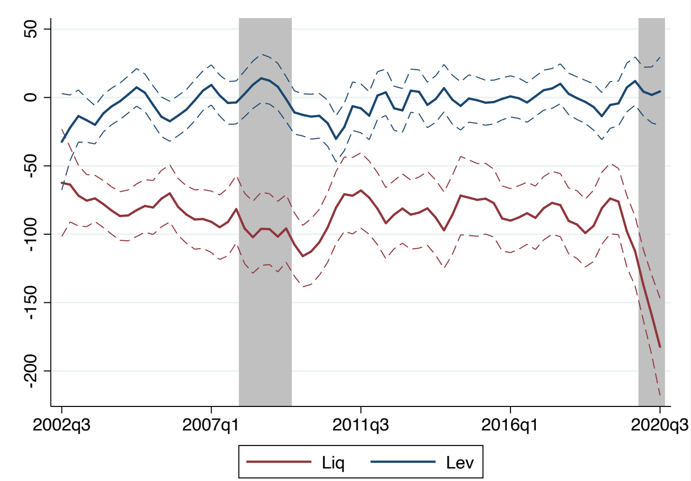
Regressions: Liquid Assets

back to empirics

Repeated cross-sections:

$$\frac{a_{f,t} - a_{f,t-2}}{a_{f,t-2}} = \alpha_{s,t} + \beta_t \text{liq}_{f,t-2} + \gamma_t \text{lev}_{f,t-2} + \Phi_t X_{f,t-2} + \epsilon_{f,t}$$

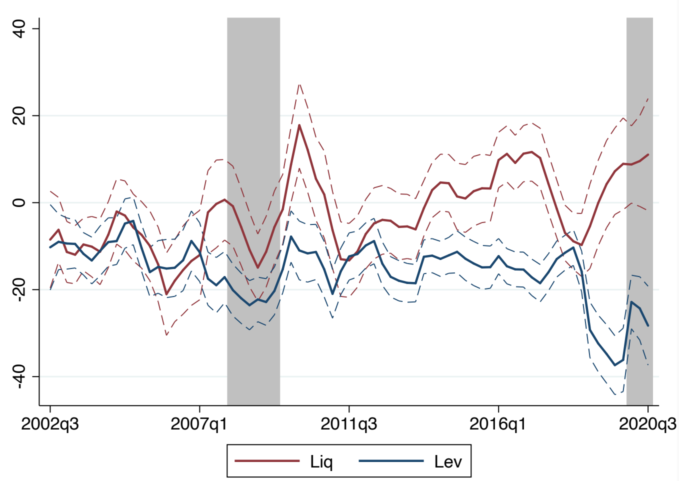


Regressions: Debt

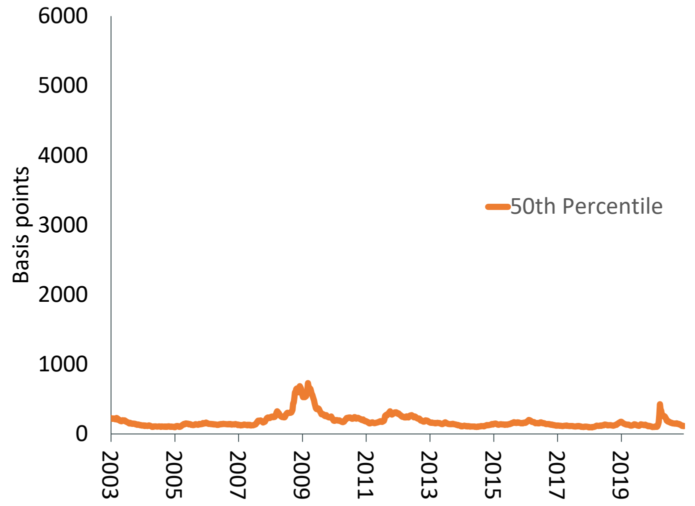
▸ back

Repeated cross-sections:

$$\frac{b_{f,t} - b_{f,t-2}}{b_{f,t-2}} = \alpha_{s,t} + \beta_t \text{liq}_{f,t-2} + \gamma_t \text{lev}_{f,t-2} + \Phi_t X_{f,t-2} + \epsilon_{f,t}$$



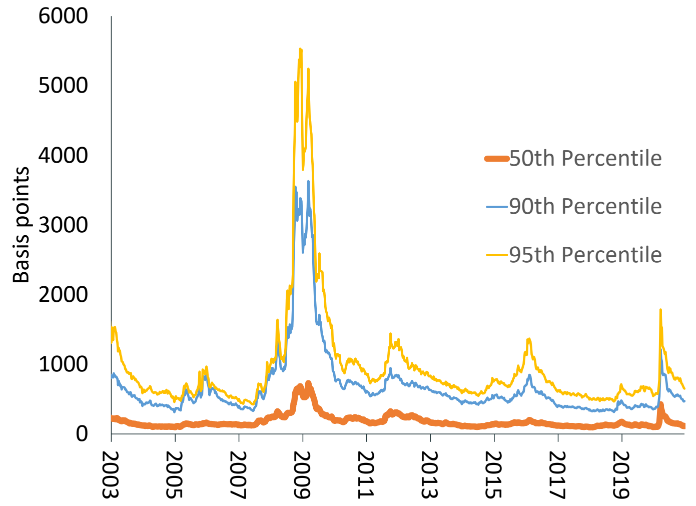
Cross-sectional Heterogeneity



- Similar movements for the median
- GFC featured larger increases at the top (90th and 95th percentiles)

  → Some firms and/or bonds suffered much more during GFC

Cross-sectional Heterogeneity



- Similar movements for the median

- GFC featured larger increases at the top (90th and 95th percentiles)

  → Some firms and/or bonds suffered much more during GFC

Environment & Technology

▸ back

- Time is discrete and infinite, $t = 0, 1, \ldots$
- Finite set of firm types, $i = 1, \ldots, N$ with mass n_i, $\sum_{i=1}^{N} n_i = 1$
- Firms produce according to a DRS production function that employs capital and labor

$$y = z^{1-\nu} k^{\alpha} \ell^{\nu}, \alpha + \nu < 1$$

- Investment in capital is subject to convex adjustment costs

$$\mathcal{A}^K(k', k) = \frac{\psi}{2} \left(\frac{k' - k}{k} \right)^2 k$$

- Firms have constant productivity z, subject to two iid shocks:
  1. **Default Shocks** ε, "preference" shocks that follow Extreme Value distribution ▸ Details on Default
  2. **Liquidity Shocks** ω, follow a binomial distribution, $\omega = \omega_i$ w.p. p_ω, zero otherwise

- State variables:

$$s = \left(\underbrace{k}_{\text{capital}}, \overbrace{b}^{\text{debt}}, \underbrace{a}_{\text{liq. assets}}, \overbrace{\omega}^{\text{liq shock}}, \underbrace{\varepsilon}_{\text{pref shock}} \right)$$

Capital Structure and Financial Frictions

▸ back

- Firms can borrow one-period debt b' at price $q(k', b', a')$

$$q(k', a', b') = (1+\chi)\frac{\overbrace{\mathcal{P}(k', a', b')}^{\text{repayment prob}}}{1+r}$$

- χ captures "preference for debt" (i.e., tax advantage)
- Firms can also invest in risk-free assets a' that yield zero return
- Risk-free assets useful to satisfy liquidity constraint at the beginning of the period

$$k \leq \omega a + m'$$

where $m' \geq 0$ intra-period borrowing that entail an increasing and convex cost

$$\mathcal{A}^M(m') = r \exp(s_m m') m'$$

- Costly equity issuance

$$\mathcal{A}^D(div) = \frac{\rho}{2}\max(-div, 0)^2$$

Firm Problem

back

$$
\begin{aligned}
V\left(k, b, a, \omega\right) &= \max_{k', a', b' \geq 0} div - \mathcal{A}^{D}(div) + \beta \mathbb{E}_{\varepsilon, \omega'}\left[\max\left\{V\left(k', b', a', \omega'\right) + \varepsilon, 0\right\}\right] \\
div &= \pi(k) + a - b + (1-\delta)k - k' + q\left(k', b', a'\right) b' - q^{a} a' - \mathcal{A}^{K}(k', k) - \mathcal{A}^{M}(m') \\
\omega k &\leq a + m' \\
\pi(k) &= \max_{\ell} z^{1-\nu} k^{\alpha} \ell^{\nu} - w\ell \\
q\left(k', b', a'\right) &= (1+\chi) \frac{\mathbb{E}\left[\mathcal{P}\left(k', b', a'\right)\right]}{1+r} \\
\mathcal{A}^{D}(div) &= \frac{\rho}{2}\left(\max\left\{-div, 0\right\}\right)^{2} \\
\mathcal{A}^{K}(k', k) &= \frac{\psi}{2}\left(\frac{k'-k}{k}\right)^{2} \\
\mathcal{A}^{M}(m') &= r \exp(s_m m') m'
\end{aligned}
$$

Sources of ex-ante heterogeneity

Firm Default

▸ back

- At the beginning of the period, firm draws iid extreme-value preference shocks $\varepsilon^D, \varepsilon^P$

$$V(k, b, a, \omega, \varepsilon^P, \varepsilon^D) = \max\left\{ V^P(k, b, a, \omega) + \varepsilon^P, V^D(k, b, a, \omega) + \varepsilon^D \right\}$$

- Normalize $V^D = 0$

- $\varepsilon = \varepsilon^P - \varepsilon^D$ follows mean-zero logistic distribution with scale κ, implying

$$\mathcal{P}(k, a, b) = \sum_{\omega} \pi(\omega) \frac{\exp[V^P(k, b, a, \omega)/\kappa]}{1 + \exp[V^P(k, ab, a, , \omega)/\kappa]}$$

Calibration

▸ back

Externally calibrated parameters:

Parameter	Value	Description
Production		
α	0.255	Capital share, Gilchrist et. al. '14
ν	0.595	Labor share, Gilchrist et. al. '14
δ	0.096	Depreciation rate
w	1	Wage, normalization
z	1	TFP, normalization
ψ	0.455	Capital adjustment, Cooper Haltiwanger '06
ρ	3	Large equity penalty, never issue equity
p_ω	0.50	Probability of liquidity shock
Prices		
β	0.95	Discount factor
r	$1/\beta - 1$	Interest rate
q^a	1	Price of liquid assets
s_m	25	Slope of intraperiod borrowing cost

Internally calibrated Parameters

▸ Identification ▸ back

- $N = 4$, four types of ex-ante heterogeneous firms
- Split matched TRACE-Compustat dataset into four groups of firms

		Value
Leverage	High	0.45
	Low	0.20
Liquidity	High	0.11
	Low	0.015
Credit Spreads		166 bps

	Model Parameter			**Model Moment**			
	debt preference (χ)	liquidity needs (ω)	idiosyncratic risk (κ)	Leverage	Liquid assets	Credit spreads	Mass n_i
High lev, high liq	0.0172	0.1682	0.5175	0.45	0.11	167	0.203
Low lev, high liq	0.0054	0.1645	0.4738	0.20	0.11	166	0.297
High lev, low liq	0.0168	0.0490	0.5602	0.45	0.015	166	0.297
Low lev, low liq	0.0053	0.0500	0.5100	0.20	0.015	169	0.203

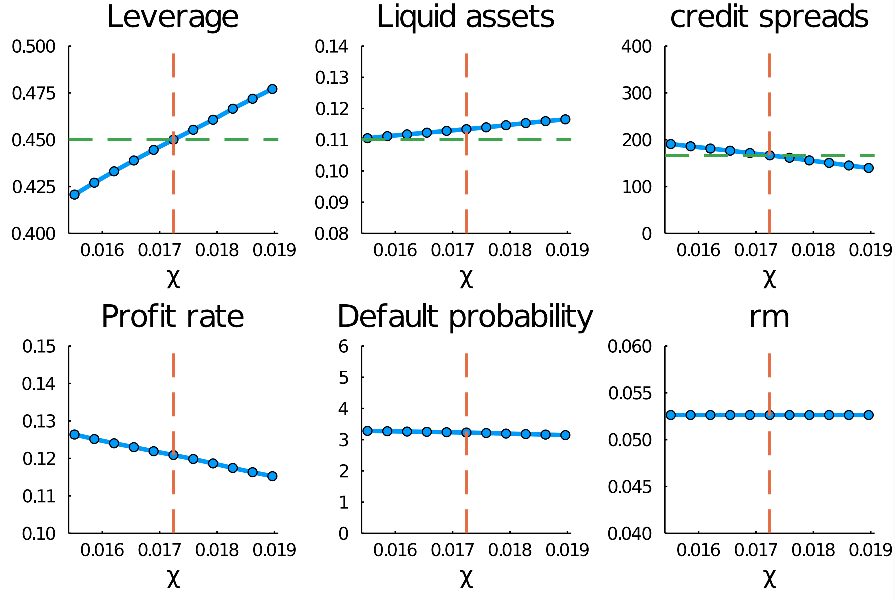
Untargeted Moments

Moment	Data, 2007Q2	Data, 2019Q4	Model
Mg Financing Cost	3.25%	3.25%	3.75 %
Investment Rate	8.56%	7.42%	6.90%
Profit Rate	13.4%	11.1%	13.0%
Debt to EBITDA	2.21	3.24	2.56
Equity payout rate	0.71%	1.52%	13.0%
Equity issuance rate	0.00%	0.00%	0.00%

Data moments correspond to Compustat medians for a given period; model moments correspond to model aggregates.

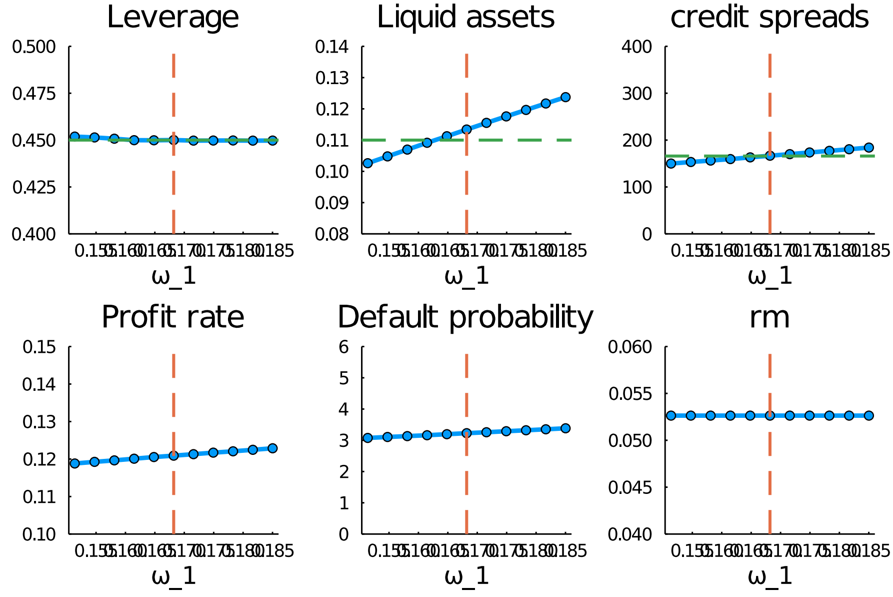
Identification: χ

back



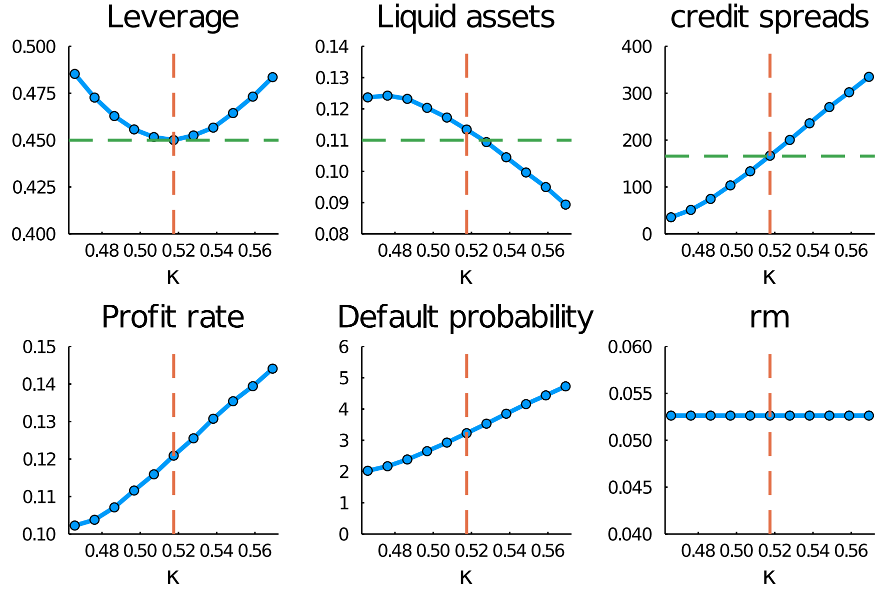
Identification: ω

▸ back



Identification: κ

▸ back



Aggregate Shocks: Details ▸ back

- Unexpected, transitory shocks, with persistence equal to $1 - \zeta$
- Aggregate variables computed as $X = \sum_{i=1}^{N} n_i x_i$
- Shock sizes chosen to match rise in spreads of 50 bps

1. **Real/TFP**: $z \downarrow$ by 25.5%
2. **Financial**: $\chi \downarrow$ by 8.8 bps
3. **Liquidity**: $\omega \uparrow$ to $\bar{\omega} = 0.235$

Policy

▸ back

We consider three policy interventions:

1. **QE**: government purchases debt securities at subsidized prices χ^{QE}, so that

$$q^{QE}(k', b', a') = (1 + \chi + \chi^{QE}) \frac{\mathcal{P}(k', b', a')}{1 + r}$$

2. **Credit Guarantees**: government commits to repay the lender a fraction ϕ^{CG} of principal in case of default

$$q^{CG}(k', a', b') = (1 + \chi) \frac{\mathcal{P}(k', a', b')}{1 + r} + \phi^{CG} \frac{1 - \mathcal{P}(k', a', b')}{1 + r}$$

3. **Transfers**: lump-sum government transfers τ, able to circumvent liquidity constraint

$$\omega k \leq a + m' + \tau$$

Effects compared to the expected cost of each policy.

Policy: Aggregate Multipliers

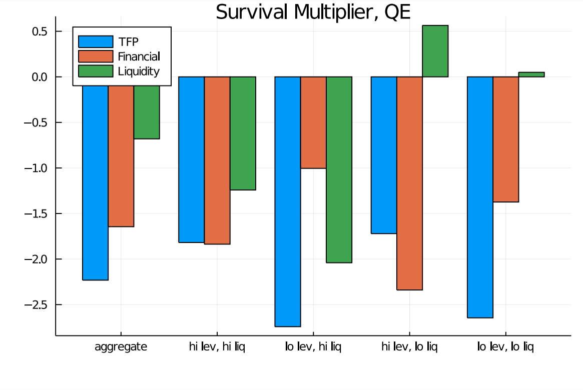
▸ back

	QE	Transfers	Credit G.
No shock			
Y	2.38	0.07	-2.18
K	6.59	0.19	-6.05
N	1.41	0.04	-1.3
Repay	-2.01	0.08	-3.83
Real shock			
Y	2.99	0.12	-2.52
K	8.25	0.32	-6.97
N	1.78	0.07	-1.5
Repay	-2.24	0.1	-4.07
Financial shock			
Y	4.21	0.12	0.67
K	11.65	0.34	1.83
N	2.51	0.07	0.4
Repay	-1.66	0.09	-2.9
Liquidity shock			
Y	2.99	0.28	0.81
K	8.32	0.79	2.44
N	1.78	0.17	0.48
Repay	-0.75	0.2	-1.59

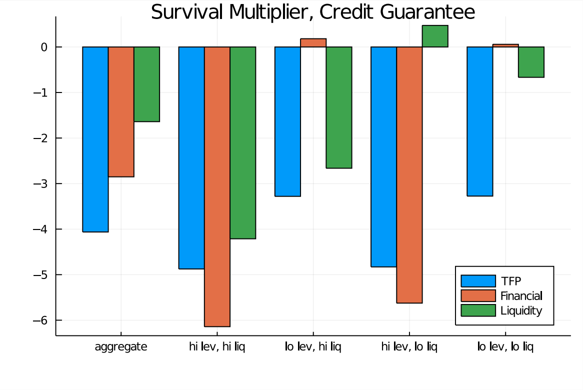
- QE always effective, even in the absence of shocks
- Credit Guarantees not effective wrt real shocks
- Transfers more effective vs. Liquidity Shocks, only policy that reduces firm default
- Real shocks relatively harder to offset with policy

Survival Multipliers: Other Policies

back



Survival Multiplier, QE



Survival Multiplier, Credit Guarantee