Firms' Rollover Risk and Macroeconomic Dynamics

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Job Market Paper

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Introduction

Motivation

- Last recessions have renewed the interest in role of financial factors in business cycles
- Potential failure of healthy firms has motivated unprecedented credit interventions
  - e.g., firm bailouts and direct lending to firms

This paper

- Macro consequences of **firms' rollover crises**
- Rollover crisis: economically solvent firm goes bankrupt because of debt rollover failure

Goal

- Quantitative macro model where rollover crises can be **identified** and **quantified**
- Implications of **firms' rollover risk** in macro dynamics and policy

What I Find

1. How **relevant** are firms' rollover crises in bankruptcy events?
   - + roughly **half** of bankruptcy events are driven by rollover crises
   - ▶ different bankruptcy choices (liquidation vs restructuring) key for identification
2. What are the **macroeconomic** implications during large recessions?
   - + rollover crises significantly **amplify** recessions
   - ▶ amplify depth and persistence → explain 10 to 30% output losses
3. What are the **policy** implications?
   - + credit policy **mitigates** rollover crises but subsidizes credit to weak firms
   - ▶ focus on direct-lending imperfectly-targeted credit policy

How I Do It

- GE model of heterogeneous firms with **default**
  e.g., Khan Senga Thomas 2016 Ottonello Winberry 2020

- Incorporate firms' **rollover crises** using tools from international macro literature
  e.g., Cole Kehoe 2000 Bocola Dovis 2020

- Bankruptcy choices **informative** of rollover crises' incidence
  Corp Law literature, e.g., Jackson 1986; and Corbae D'Erasmo 2021

- **Quantitative** analysis of U.S. economy
  amplification of output losses and credit policy in recessions

Related Literature

- **Financial heterogeneity and default risk in macro**

  Cooley Quadrini 2001 Hennessy Whited 2005 Cooley Marimon Quadrini 2004 Jermann Quadrini 2012 Arellano Bai Kehoe 2019 Khan Senga Thomas 2020 Ottonello Winberry 2020 Corbae D'Erasmo 2021

  + incorporate rollover crises jointly with bankruptcy procedure

- **Rollover crises in macro-finance**
  - banks: Gertler Kiyotaki 2015 Amador Bianchi 2021
  - sovereign debt: Cole Kehoe 2000 Bocola Dovis 2020 Aguiar Chatterjee Cole Stangebye 2021
  - corporate finance theory: Morris Shin 2004 He Xiong 2012a,b; Cheng Milbradt 2012 Zhong 2021
  - bankruptcy law: Jackson 1986 Ayotte Skeel 2013

  + quantification for firms using bankruptcy choices

- **Direct credit policy interventions in recessions**

  Crouzet Tourre 2021 Elenev Landvoigt Van Nieuwerburgh 2021 Ebsim Faria-e-Castro Kozlowski 2021

  + policy works through insurance channel with rollover risk

Outline

- Macro Model of Firms' Rollover Crises
- Identification
- Macroeconomic Consequences

Outline

- **Macro Model of Firms' Rollover Crises**
- Identification
- Macroeconomic Consequences

Overview of the Model

Environment

- GE framework populated by heterogeneous firms
- Firms use internal resources and borrow to finance investment and production
- Other agents: HHs, creditors, and capital producer

Three key ingredients

1. Endogenous default risk
2. Debt rollover crises
3. Heterogeneous firms and bankruptcy choices

Firms Objective

- Firm i objective is to max $\mathbb{E}$ discounted value of dividends

$$V_{i0} = \sum_{t \geq 0} \mathbb{E}_0[\Lambda_t d_{it}]$$

with Λ_t HH's SDF and d_{it} firm's dividends

Technology

Firms hire l at wage w and use inherited k to produce unique final good with technology

$$f(z, \omega, k, l) = z\,(\omega k)^{\alpha}\, l^{\nu}$$

- DRS in (k,l) $\alpha + \nu < 1 \rightarrow$ optimal size
- persistent productivity shock $z = \rho_z z_{-1} + \epsilon_z$ where $\epsilon_z \sim$ iid
- capital quality shock $\omega \sim$ iid log-normal truncated for quant purposes
  - changes effective value of capital

Resources

Each period, firms inherit (k, b) and decide (k', b')

- Cash-on-hand

$$n = \underbrace{\max_l f(z, \omega, k, l) - wl}_{\text{operational profits}} + \underbrace{(1-\delta)q\omega k}_{\text{selling value of capital}} - \underbrace{b}_{\text{maturing debt}}$$

- Flow of funds constraint

$$\underbrace{d}_{\text{dividends}} = \underbrace{n}_{\text{internal resources}} + \underbrace{Q(.)b'}_{\text{external resources}} - \underbrace{qk'}_{\text{capital purchases}} \geq 0$$

Debt Price and Sunspot Shock

- Debt price schedule

$$Q\left(z, n, \phi, k', b'\right)$$

  depends on current and future default decisions

- **Sunspot** shock
  1. firms draw $\phi \sim U[0,1]$ **iid** across time and firms
  2. if $\phi < \eta$ then $Q = 0$ for firms exposed to rollover crises
  3. η common across firms

Bankruptcy

Emulating US Bankruptcy Code bankrupt firms can choose to

1. **Liquidate** and exit (Chapter 7)
   - creditors recover $\alpha_7 \in [0,1]$ of k and firm exits with value $V = 0$
   - choice **after** issuing b′ (Cole-Kehoe 2000)

2. **Restructure** liabilities and continue operating (Chapter 11)
   - internal resources if firm restructures

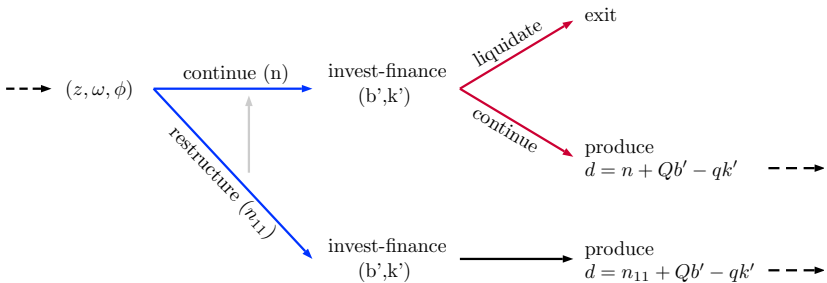
$$n_{11} = n + \underbrace{(1 - \alpha_{11})b}_{\text{benefit}} - \underbrace{c_{11}k}_{\text{cost}}$$

   debt haircut $(1 - \alpha_{11}) \in [0,1]$ endogenous bargaining protocol and cost $c_{11} \geq 0$

   - **no rollover crises** in new debt issuance b′

US bankruptcy code institutional details

Within Period Timing



- all uncertainty realized at the beginning of the period
- characterize firm choices backwards

note: timing for non-exit firms

(Exogenous) Entry and Exit

Technical and quantitative assumptions

- Exogenous exit probability γ (KST 2016, stationary dist)
  - if receive shock the firm exits after production

- Entrants enter on average productivity $m\%$ below ergodic distribution average (OW 2020, life-cycle firms)

more details

Multiple Equilibria

- Firm choose to liquidate if they can't satisfy $d \geq 0$
- Feedback between debt price and default choice of firms today

$$Q = \underbrace{\mathbb{I}_{d \geq 0}}_{\text{liquidation choice}} \quad \underbrace{\tilde{Q}}_{\text{price if no liquidation}}$$

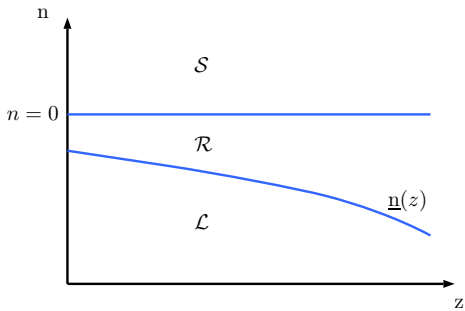
$$d = n - qk' + Qb' \geq 0$$

- Multiplicity if

$$\begin{aligned} Q = 0 &\iff d < 0 \quad \text{(rollover crises)} \\ Q > 0 &\iff d \geq 0 \quad \text{(repay)} \end{aligned}$$

Liquidation

- **Fundamental** state-space (z, n) is divided in three regions



- $\mathcal{S}$: $Q = 0$ then continue if $d = n + \underbrace{\max_{k'}\{-q\,k'\}}_{0} > 0$
- $\mathcal{L}$: $Q = \tilde{Q}$ then liquidate if $d = n + \underbrace{\max_{k',b'}\{-q\,k' + \tilde{Q}\,b'\}}_{-\underline{n}(z)} < 0$
- $\mathcal{R}$: liquidate if $Q = 0$, continue if $Q = \tilde{Q} > 0$

- **Rollover crisis** when firm is in $\mathcal{R}$ (solvent) but $\phi < \eta$
- if $\eta \to 0$ then only fundamental defaults (e.g., KST, OW) rollover risk

more general costly equity issuance

Restructuring

Firms restructure their liabilities if

1. firm insolvent or with rollover crisis (key: outside option is to continue)
2. creditors recover more than in liquidation: $\alpha_{11} > R(\omega, b, k) \equiv \min\left\{1, \alpha_7 \frac{(1-\delta) q \omega k}{b}\right\}$
3. firm satisfies $d \geq 0$ after restructuring: $n_{11} \geq \underline{n}(z)$

Nash bargaining further details

Illustrative parametrizations

- $c_{11} \to \infty$: fundamental and non-fundamental liquidations
- $c_{11} = 0$ and $\alpha_{11} = 1$ (i.e., $n = n_{11}$): only fundamental liquidations

Q and restructuring

Firm's Problem

- $\tilde{V}(z, n)$ value of solvent firm without a rollover crisis today

$$\tilde{V}(z, n) = \max_{d, k', b'} d + \mathbb{E}_{(z'|z;\omega';\phi')} \left[\Lambda \left\{(1-\gamma) V(s') + \gamma V_{\text{exit}}(s)\right\}\right]$$

subject to

$$d = n - qk' + \tilde{Q}\left(z, b', k'\right) b' \geq 0$$
$$s' = (z', \omega', \phi', k', b')$$

where $\tilde{Q}(.)$ fundamental debt price details Q and $V_{\text{exit}}(s)$ value of exiting firm details exit

  - policy functions $k'(z, n)$ and $b'(z, n)$ solve dynamic problem

- $V(.)$ before restructure choice for non-exiting firms

$$V(s) = \left[1 - 1_{\{ch11\}}(s) - 1_{\{ch7\}}(s)\right] \tilde{V}(z, n) + 1_{\{ch11\}}(s) \tilde{V}(z, n_{11})$$

where liquidation and restructuring choices are consistent with characterization

Other Agents and Equilibrium

1. Households detail
   - labor supply
   - Euler equation and SDF Λ
2. Capital producer detail
   - sells capital at price q
   - standard aggregate capital adjustment function
3. Creditors detail
   - debt price Q through no-profit condition
   - discount at SDF Λ

Equilibrium full definition distribution's law of motion

- steady state and transitions

Outline

- Macro Model of Firms' Rollover Crises
- **Identification**
- Macroeconomic Consequences

Identification

Questions

- How many firms are in $\mathcal{R}$?
- Value of η?

Steps

1. Calibration of **standard** parameters to match relevant moments of U.S. economy
2. Calibration of parameters related to **bankruptcy procedure**
   - validate with bankruptcy predictors and investment dynamics during recessions
3. Quantify η and share of exposed firms

Data sources

- NIPA, Compustat, Federal Judicial Center-IDB, LBD, other papers

Calibration Standard Parameters

Calibration strategy

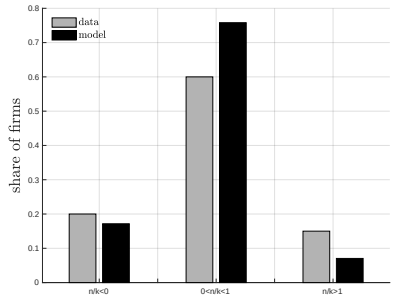
- 9 fixed and 4 fitted parameters not related to rollover crises and bankruptcy
- parameters: preferences, technology, stochastic process, entry/exit
- fit moments: employment, investment, balance sheet, life-cycle

Parameter	Value	Calibration
Fixed		
$\beta = 1/(1+r)$	0.99	fixed to $r = 0.05$ annual
Φ	1.16	fixed to match 58% emp rate
ν	0.64	fixed labor share
α	0.21	fixed capital share
δ	0.025	fixed to match BEA quarterly
ρ_z	0.90	fixed
γ	0.02	fixed to exit rate w/o default
ψ	2	agg AC fixed to lit standard
b_0	0	fixed to no net debt entrants
Fitted		
σ_z	0.032	internally calib
$\underline{\omega}$	-0.33	internally calib
k_0	0.16	internally calib
m	-0.24	internally calib

Relevant Moments

Moment	Data	Model
Credit spreads		
credit spread: $\mathbb{E}[r^Q - r]$	0.02	0.01
default rate: $\mathbb{E}[\mathbf{1}_{Ch7} + \mathbf{1}_{Ch11}]$	0.03	0.03
Investment heterogeneity		
avg invest rate: $\mathbb{E}[i/k]$	0.12	0.17
sd invest rate: $SD[i/k]$	0.34	0.36
Life-cycle		
share exit	0.10	0.11
(L age 1) / L	0.03	0.04
# firms age 1 / # firms	0.10	0.11
# firms age 2 / # firms	0.08	0.09
Aggregates		
K/Y	3.00	2.59
I/Y	0.17	0.15
gross debt: $\mathbb{E}[1_{b>0}b]/Y$	1.05	1.79

n distribution



measurement

Calibration Bankruptcy

- $(\alpha_7, \psi_{11}, c_{11})$ match debt haircut under Ch 11 and Ch 7, and leverage in Ch 11

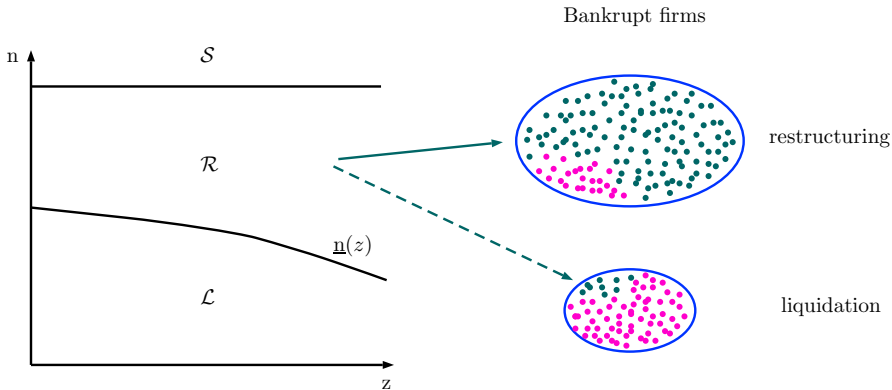
Param.	Value	Moment targeted	Data	Model
α_7	0.38	$\mathbb{E}[R_7]$	0.27	0.29
ψ_{11}	0.89	$\mathbb{E}[\alpha_{11}]$	0.69	0.82
c_{11}	0.40	$\mathbb{E}[b'/k' \mid \text{Ch 11}]$	0.73	0.67

Untargeted moments

- distribution of leverage in Ch 11 and predictors of Ch 11 validation
- investment heterogeneity in last recessions details

Identification of η Intuition

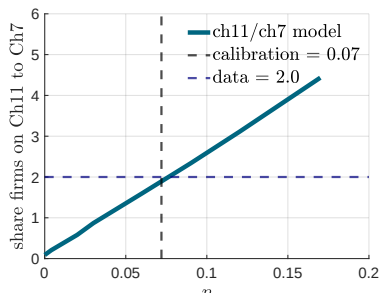
- with rollover crises



proposition

Incidence of Rollover Crises (1/2)

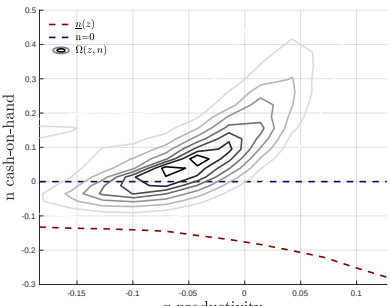
- higher η (in stst) then higher share of firms in Ch 11 (relative to Ch 7)



- $\eta \approx 0.07$

Incidence of Rollover Crises (2/2)

Steady state distribution $\Omega(z, n)$
before bankruptcy choice



$$\underbrace{\int_{(z,n)\in\mathcal{R}} d\Omega(z,n)}_{\text{share of firms exposed}} \times \underbrace{\eta}_{\text{crises likelihood}} = 1.5\%$$

share of firms exposed: 0.20

crises likelihood: 0.07

Result I: roughly half of bankruptcy events are rollover crises

Outline

- Macro Model of Firms' Rollover Crises
- Identification
- **Macroeconomic Consequences**

Macroeconomic Consequences

1. Recessions
2. Policies

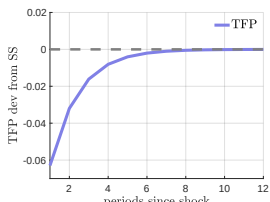
- perfect foresight path of unexpected shock

Recession Shocks

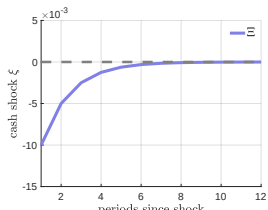
- Shocks unexpected and perfect foresight of path
- Temporary with persistence 0.5
- Definition of shocks:
  - TFP A: prod funct $Azf(k, \omega, l)$
  - Cash ξ: reduction in n by ξk

Shocks' path

TFP A



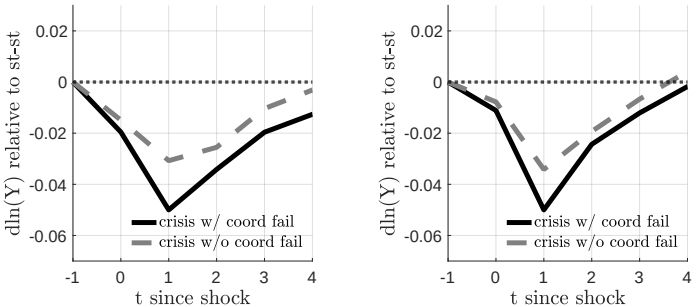
Cash ξ



Study path of Y with and without rollover crises in the recession

Recessions and Rollover Crises

TFP A | Cash ξ



η shock st-st comparison

- Firm exit increases details

Result II: rollover crises explain 15% to 30% of output losses in recessions

Credit Policy Intervention

- Direct lending policy: external resources for firm eligible to the policy are

$$\max\{\underbrace{Q(s, b', k')}_{\text{market}}, \quad \underbrace{Q^g(.)}_{\text{government}} \} \times b'$$

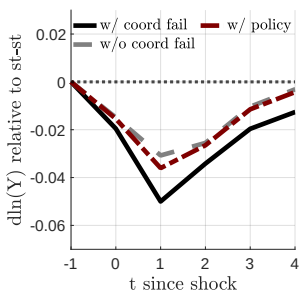
- Policy workings: take elegible firm with $(z, n) \in \mathcal{R}$ under a rollover crisis
  - if $d = n + \max_{k',b'}\{-qk' + Q^g b'\} > 0 \implies$ **preclude crisis**
- Imperfect policy faces trade-off between precluding rollover crises and future debt overhang parametrization announcement and implementation direct lending vs credit guarantees

Study policy effectiveness in the recession

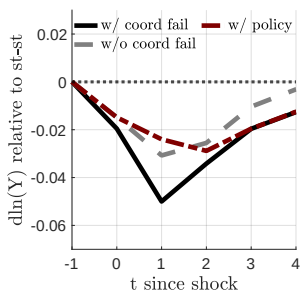
Credit Policy Quantification

- Policy active for first two periods and TFP shock driven crisis cash shock fiscal losses

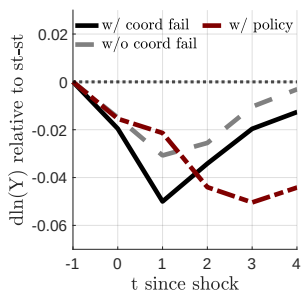
low scale



medium scale



large scale



Result III: imperfectly-targeted credit policy benefits are ambiguous

Concluding remarks

Concluding remarks

- Quantitative framework with heterogeneous firms and rollover crises
- Bankruptcy choices indicative of rollover crises incidence
- Results
  1. rollover crises are relevant way how firms fail
  2. rollover crises can significantly amplify recessions
  3. credit policy has ambiguous benefits

Future research avenues

- Extensions: (i) liability structure management (ii) heterogeneous investors
  liab structure data ex-ante cost
- Empirical work
- Other applications (e.g., sovereign debt, financial firms)

Thank you!

Extra Slides

US Bankruptcy Code

Bankrupt firms use chapter 11 (11 U.S.C.) or 7 (7 U.S.C.) of US bankruptcy code

- Chapter 7
  - associated with firm's liquidation
  - case impartial trustee appointed to sell the bankrupt firms assets to pay creditors
- Chapter 11
  - associated with firm's restructure (or reorganization)
  - large firms also use to piecemeal liquidate the firm ("363 sale", 11 U.S.C. § 363(a))
  - debtor presents plan, and needs to be approved by judge and, ultimately, negotiated with and voted by creditors
  - provisions to preclude creditor's coordination problem, e.g.,
    1. automatic stay 11 U.S.C. § 362(a): prevents creditors demand payment
    2. debtor-in-possession protection 11 U.S.C. § 1101: allows new financing
    3. creating creditors' committees 11 U.S.C. § 341

back

Bankruptcy Procedure

- Only firms that are insolvent or under a rollover crises may restructure their debt
- Recovery rate $\alpha_{11}(.)$ determined by

$$\alpha_{11}(z,k,b,\omega) = \arg\max_{\alpha_{11}} \underbrace{\left[V\left(z,n^{11}\right) - 0\right]^{1-\Xi}}_{\text{firm's surplus}} \underbrace{\left[\alpha_{11} b - R(k,b,\omega)\, b\right]^{\Xi}}_{\text{creditor's surplus}}$$

  where $\Xi \in [0,1]$ barg power of creditors, we need that $n_{11} > \underline{n}(z)$ and $\alpha_{11} > R(k,b,\omega) = \min\{1, \alpha_7 (1-\delta) q\omega k/b\}$

- For computational reasons I approx the barg. Max recov rate $\{\alpha_{11}^{max} : n_{11} = \underline{n}(z)\}$ and min recov rate $\alpha_{11}^{min} = \alpha_7^{min} = R(k,b,\omega)$, then recov rate linear comb of those rates with $\psi_{11} \in (0,1)$ the weight to creditors

back setup back restructure back debt price

Entry and Exit

Exogenous exit

- Firms receive exog exit shock with prob γ
- Exiting firms allowed to restructure and liquidate before producing then

$$V^{\text{exit}}(s) = 1_{\{\text{continue} \mid \text{exit}\}}(s)\, n + 1_{\{\text{ch11} \mid \text{exit}\}}(s)\, n_{11}^{\text{exit}}$$

- Liquidate if $n < 0$ and $n_{11}^{\text{exit}} > 0$ not feasible; restructure if $n < 0$ and $n_{11} > 0$ feasible
- Price of debt conditional on exit is

$$\tilde{Q}_{\text{exit}}\left(z, k', b'\right) = \mathbb{E}_{\left(s' \mid s\right)}\left[\Lambda\left\{1_{\{\text{continue} \mid \text{exit}\}}\left(s'\right) + 1_{\{\text{ch11} \mid \text{exit}\}}\left(s'\right)\alpha_{11}^{\text{exit}}\right\}\right]$$
$$+ \mathbb{E}_{\left(s' \mid s\right)}\left[\Lambda 1_{\{\text{ch7} \mid \text{exit}\}}\left(s'\right) R\left(\omega', b', k'\right)\right]$$

Entry

- Mass $\bar{\mu}$ enter each period replacing exiting firms (for all reasons)
- Enter with capital $k = k_0$, $b = 0$ and $z \sim \Omega^e(z)$

back setup back value function back debt price

Liquidation Choice: More General Setup

Long-term debt

- assume portion debt m matures each period (randomly) and nonmatured pays cupon c
- cash-on-hand: $n = \pi + q\omega(1-\delta)k - [m + (1-m)c]b$
- external funds: $Q(.)\left[b' - (1-m)\,b\right] - qk'$
- default threshold: if $n \in [\underline{n}(z,b), 0)$ exposed to rollover crises and $n < \underline{n}(z,b)$ insolvent
- (recursive) debt prices (simplified = no bkrptcy, no exit, no discount, $c = 0$, $\alpha_7 = 0$):

$$\tilde{Q}(z,k',b') = \mathbb{E}_{z'|z}\left[\left\{1_{n'\geq 0} + (1-\eta)\,1_{n'\in[\underline{n}(z',b'),0)}\right\}\left\{(1-m)\,\tilde{Q}(z',k'',b'') + m\right\}\right]$$

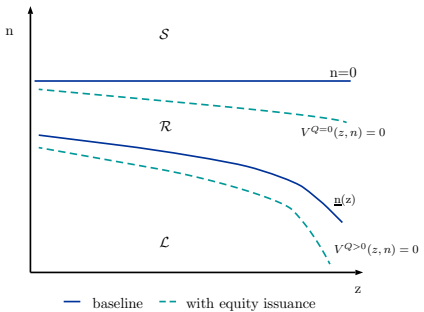
More general (assume $c = 0$ for exposition)

- profits $\pi(\mathbf{z},k)$ gral $\mathbf{z}$ process, invest $\iota\left(k,k'\right)$ allow for idio k frictions and long-term debt
- dividends (if no roll crises) are $d = \pi(\mathbf{z},k) - \iota\left(k,k'\right) - bm + \tilde{Q}(.)\left(b' - (1-m)\,b\right)$
- multiple eq if $\max_{k',b'} d \geq 0$ and $n \equiv \pi(\mathbf{z},k) - bm - \iota(k,0) < 0$ hold

back liquidation back debt price

Liquidation Choice: Costly Equity Issuance

- Firms can issue equity $e < 0$ at cost $\phi(e)$, which is decreasing in e and unbounded.



- $\mathcal{S}$: $V^{Q=0}(z,n) \geq 0$
- $\mathcal{L}$: $V^{Q>0}(z,n) < 0$
- $\mathcal{R}$: $V^{Q>0}(z,n) \geq 0$ and $V^{Q=0}(z,n) < 0$

- Where $V^{Q=0}$ firm problem with costly equity issuance where $Q = 0$ and $V^{Q>0}$ same but with $Q > 0$

back

Rollover Risk

- Firm-level credit spread

$$\frac{\tilde{r}\left(z, b', k'\right) - r}{1 + \tilde{r}\left(z, b', k'\right)} = \underbrace{Pr\left[\left(n', z'\right) \in \mathcal{L} \mid z\right]}_{\text{insolvency risk}} + \underbrace{\eta Pr\left[\left(n', z'\right) \in \mathcal{R} \mid z\right]}_{\text{rollover risk}}$$

assume no rollover crises today, no restructuring, $\Lambda = 1/(1+r)$,$\alpha_7 = 0$ and $\gamma = 0$

- Aggregate-level incidence of rollover crises

$$\underbrace{\int_{z, n < \underline{n}(z)} d\Omega\left(z, n\right)}_{\text{insolvent firms}} + \eta \times \underbrace{\int_{z, n \in \left[\underline{n}(z), 0\right)} d\Omega\left(z, n\right)}_{\text{exposed firms}}$$

note: if $\eta \to 0$ then back to model with defaults only driven by fundamentals

back

Bankruptcy and Debt Prices

- Firm-level credit spreads $(\Lambda = 1/(1+r), \alpha_7 = 0, \gamma = 0)$ full Q

$$\frac{\tilde{r} - r}{1 + \tilde{r}} = \underbrace{\mathbb{E}\left[1'_{\{ch7\}}\right]}_{\text{liquidation}} + \underbrace{\mathbb{E}\left[1'_{\{ch11\}} \times \left(1 - \alpha'_{11}\right)\right]}_{\text{restructuring}}$$

- Model nests
  - $c \to \infty$

$$\frac{\tilde{r} - r}{1 + \tilde{r}} \approx \mathbb{E}\left[1'_{\{ch7\}}\right] = Pr\left[\left(n', z'\right) \in \mathcal{L} \mid z\right] + \eta Pr\left[\left(n', z'\right) \in \mathcal{R} \mid z\right]$$

  - $c = 0$ and $\alpha_{11} \to 1$ then spreads are

$$\frac{\tilde{r} - r}{1 + \tilde{r}} \approx \mathbb{E}\left[1'_{\{ch7\}}\right] = Pr\left[\left(n', z'\right) \in \mathcal{L} \mid z\right]$$

back

Corporate Debt Prices

- $Q = [1 - \mathbf{1}_{ch7}(s)]\tilde{Q}$ from creditor's no profit condition
- $\tilde{Q}$ determined by (discounted) $\mathbb{E}$[prob tomorrow's bankruptcy events]

$$\begin{aligned}\tilde{Q}\left(z, k', b'\right) = &(1-\gamma)\,\mathbb{E}_{\left(z'|z,\omega',\phi'\right)}\left[\Lambda 1_{\{\text{continue}\}}\left(s'\right) \times 1\right] \\ &+ (1-\gamma)\,\mathbb{E}_{\left(z'|z,\omega',\phi'\right)}\left[\Lambda 1_{\{Ch11\}}\left(s'\right) \times \alpha_{11}\left(s'\right)\right] \\ &+ (1-\gamma)\,\mathbb{E}_{\left(z'|z,\omega',\phi'\right)}\left[\Lambda 1_{\{Ch7\}}\left(s'\right) \times R\left(k', b', \omega'\right)\right] \\ &+ \gamma \tilde{Q}_{\text{exit}}\left(z, k', b'\right)\end{aligned}$$

where

- $\alpha_{11}(s)$ recovery rate of creditors if restructure bargain protocol
- $R(k, b, \omega) = \min\{1, \alpha_7 (1-\delta) q\omega k / b\}$ recovery rate if liquidated
- $\tilde{Q}_{\text{exit}}\left(z, k', b'\right)$ debt price conditional on exit shock Q with exogenous exit

long-term debt example back firm problem back eq

Qualitative Identification of η

Proposition (Identification of η)

Assume that in the restructuring process the debt haircut haircut is α_{11} fixed and bankruptcy costs are a fixed cost $c_{11} \in (0, -\underline{n}(z_{max}))$ with z_{max} highest productivity firm in the economy. Then for a given distribution of firms

1. *if $\alpha_{11} \longrightarrow 1$ then firms that are insolvent don't restructure their debt,*
2. *if $\alpha_{11} \longrightarrow 1$ then the share of firms that restructure their debt (i.e., $(z, n) \in \mathcal{R}$ with $n_{11} \geq n$) identifies η,*
3. *if $\alpha_7 < \alpha_{11} < 1$ then firms with higher debt require a smaller c_{11} to restructure.*

back

HH Problem

HH in equilibrium determines

$$\Lambda' = \beta \frac{U_C(C', L')}{U_C(C, L)}$$

$$1 = E\left[\beta \frac{U_C(C', L')}{U_C(C, L)}(1 + r)\right]$$

$$w = -\frac{U_L(C, L)}{U_C(C, L)}.$$

with utility function $U_C(C, L) = \ln C - \Omega L$

back back eq

Capital Producer

There is a representative aggregate capital producer that maximizes

$$\max_{I} q\Phi\left(\frac{I}{K}\right) - I$$

where I is the amount of final goods used to produce capital, K is the aggregate k stock, and $\Phi(.)$ is the aggregate capital adjustment cost function. FOC:

$$q = \frac{1}{\Phi'\left(\frac{I}{K}\right)}$$

- time-varying q and $\mathcal{R}(.) \rightarrow$ financial accelerator mechanism (Bernanke, Gertler & Gilchrist 1999).

back back eq

Steady-State Equilibrium

Steady-state equilibrium in this economy is Vfunctions of continuing firms $\{V, \tilde{V}\}$, decision rules $\{b', k', l\}$, aggregates $\{Y, C, I\}$, price schedule $Q(.)$, interest rate r, prices $\{q, w\}$, default choices $1(.)$, recov rates $\alpha_{11}(.)$ and distribution of firms $\{\Omega(.)\}$

- HHs choices are determined by Euler eq, SDF and labor supply eq detail
- price of capital q determine in K producer problem detail
- debt price satisfy no-profit condition of fin intermediaries detail
- given prices, firm's dec. rules solve the producing firm's problem detail and default choices are consistent with Default Propositions
- recovery rates satisfy bargaining protocol
- markets clear (labor, resources)
- distribution of firms **fixed point** in law of motion detail

back

Law of Motion States

Let Ω be the distribution of firms that produce which they a mass of 1, $\tilde{\Omega}$ the distribution of incumbent firms at the begining of the period, g and $\hat{g}$ the pdf of ω and ϕ respectively, p the conditional pdf of the productivity shocks ϵ_z, and Ω^e the distribution of entrant firms. To define the equilibrium first we need to determine the law of motion of the distribution. Distribution of firms that produce is

$$\begin{aligned}\Omega(z,n) = (1-\gamma)\int\left[1_{\{ch11\}}(s)\,1_{\{n^{11}(z,k,b,\omega)=n\}} + 1_{\{cont\}}(s)\,1_{\{n(z,k,b,\omega)=n\}}\right]d\tilde{\Omega}(s)\\ + \bar{\mu}(1-\gamma)\int\left[1_{\{ch11\}}(s)\,1_{\{n^{11}(z,k_0,0,\omega)=n\}} + 1_{\{cont\}}(s)\,1_{\{n(z,k_0,0,\omega)=n\}}\right]\hat{g}(\phi)\,g(\omega)\,d\phi d\omega d\Omega^e(z)\\ + \text{lom} \mid \text{exit}\end{aligned}$$

The distribution of incumbent firms at the begining of the period $\tilde{\Omega}(z,\omega,k,b,\phi)$ is

$$\tilde{\Omega}\left(s'\right) = \int 1_{\{k'(z,n)=k'\}}1_{\{b'(z,n)=b'\}}\hat{g}\left(\phi'\right)g\left(\omega'\right)p\left(\epsilon_z \mid \rho_z z + \epsilon_z = z'\right)d\epsilon_z d\Omega(z,n)$$

back eq def back eq paper

Data Sources, Sample and Some Definitions

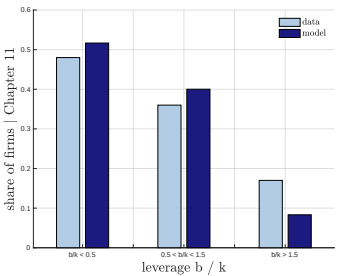
Compustat

- Two samples (accounting changes after 2018, see Ma's online notes)
  - Pre-covid = 1980-2017 (n=179k annual, n=426 k quarterly)
  - Covid = 2019-2020 (n=14k quarterly)
- Sample selection: nonfinancial, $k > 0$, assets > 0, drop outliers and short-spell (<20 q spell)
- Key definitions:
  - n = profits + liq value capital − net liquid liabilities
  - profits = F1.`oiadpq` where F1 = one period ahead in the data
  - net liquid liabilities = `lctq` − `cheq`
  - liq value capital = `invtq` $\times \omega_{inv}$ + `rectq` $\times \omega_{rec}$ + `ppentq` $\times \omega_{ppentq}$ + `acoq` where ω_x is liq value rate (from Kermani Ma 2020) of asset class `x`
- Identify bankrupt firms that operate following Corbae D'Erasmo 2021. Use footnote to total assets and deletion information (`dlrsn` and `dldte`). Bankrupt firms:
  1. report adoption accounting under Ch11, or bankrupt and not deleted
  2. data available next period

back calibration back invest het back invest het by episode

Untargeted Moments of Bankruptcy

Distribution of leverage b′/k′ firms in Chapter 11



Predictors of Chapter 11

dependent variable: $1^{ch11}_{i,t}$

	(1)		(2)		(3)	
	data	model	data	model	data	model
$n_{i,t-1}/k_{i,t}$	-0.39	-0.05			-0.39	-0.45
	(0.03)				(0.10)	
$b_{i,t}/k_{i,t}$			0.11	0.03	-0.29	-0.41
			(0.04)		(0.09)	
$\log(k_{i,t-1})$	-0.50	-0.06	-0.52	-0.06	-0.49	-0.10
	(0.12)		(0.12)		(0.12)	
$d\log(sales_{i,t-1})$	-0.04	-0.03	-0.04	-0.02	-0.04	-0.01
	(0.00)		(0.00)		(0.00)	
Sector FE	Y		Y		Y	
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y	
Observations	370,973		373,362		370,973	

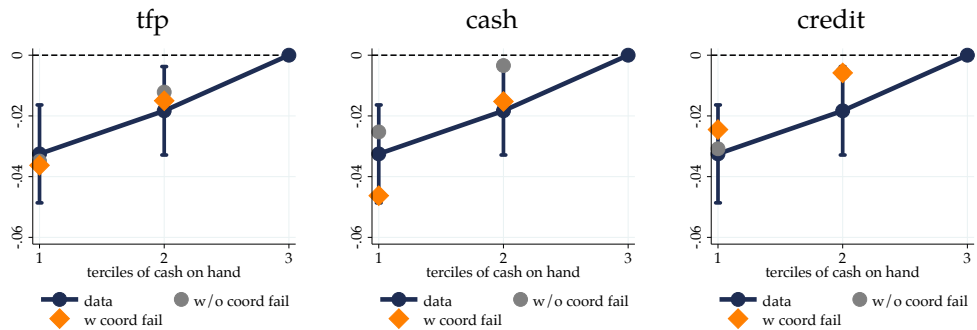
empirical specification: $1^{ch11}_{i,t} = \beta X_{i,t-1} + \alpha_t + \alpha_i + \alpha_s + \epsilon_{i,t}$

back

Investment Adjustment Heterogeneity

- Estimate heterogeneity in Δk adjustments during crises empirical specification measurement
- Data and model simulation for Great Recession and Covid episodes

Heterogeneity of Δk(crisis) − Δk(no crisis)



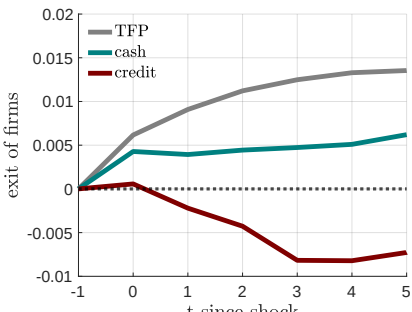
note: simple average of both episodes individual episode empirical results other shocks

back

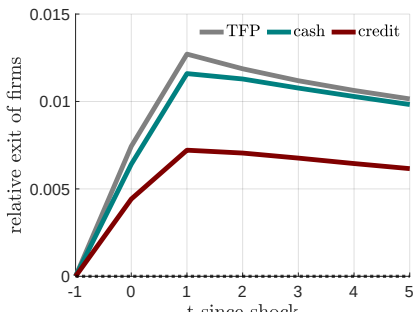
Firm (net) Exit During Recessions

- Firm exit dynamics during crisis experiments

Exit rate(t) − Exit rate(SS)

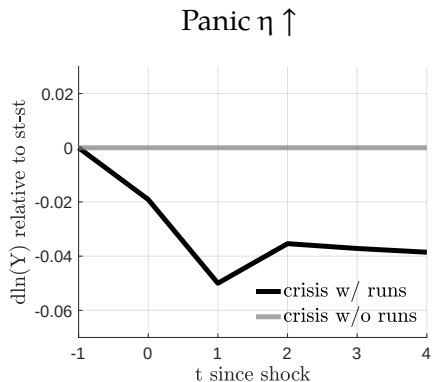


Exit rate(t; η) − Exit rate(t; η = 0)



back

Rollover Crises and Panics

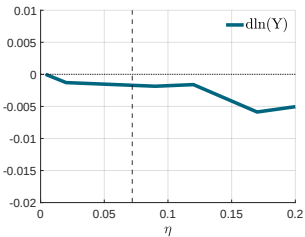


back

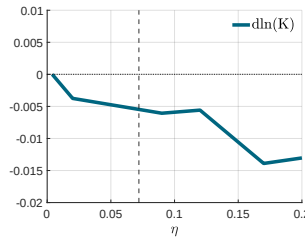
Steady State Comparison

- Variables: aggregate income Y, capital, K and share of firms with $n < 0$
- Comparison: steady state for different η

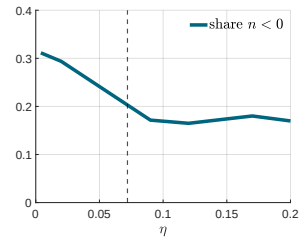
Y



K



share of firms with $n < 0$



notes: log difference relative to st-st with $\eta = 0$ for Y and K and levels for share of firms

back

Heterogeneous Investment Response
Empirical Specification

- Diff-in-diff crisis event estimate
  similar to Kalemli-Özcan Laeven Moreno 2020

$$\Delta \log(k_{it}) = \underbrace{\sum_{j=1}^{J} \beta_j^n \left(Q_{it}^{nj} \times \text{crisis}_t \right)}_{\text{heterogeneity across } n/k} + \underbrace{\sum_{j=1}^{J} \beta_j^b \left(Q_{it}^{bj} \times \text{crisis}_t \right)}_{\text{heterogeneity across } b/k} + \underbrace{\Lambda' Z_{it}}_{\text{controls}} + \varepsilon_{it}$$

let $x_{it} = \{b_{it}, l_{it}\}$ firm i at period t with

- demeaned by sector $\hat{x}_{it} = x_{it} - \mathbb{E}_s[x_{it}]$.
- $\Delta \log(k_{it}) = \log(k_{it+h}) - \log(k_{it})$ with h peak-to-trough length
- crisis_t indicates if a crisis happens during the period considered
- $Z_{i,t}$: sales growth, log firm size, firm FE, sector FE

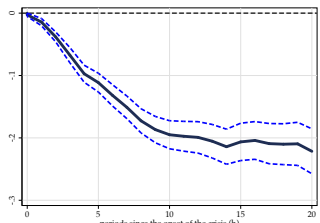
back

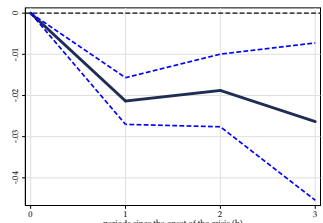
Recent Crisis Episodes in U.S.

(a) Great Recession

(b) Covid-19 Crisis

Δ Capital Accumulation

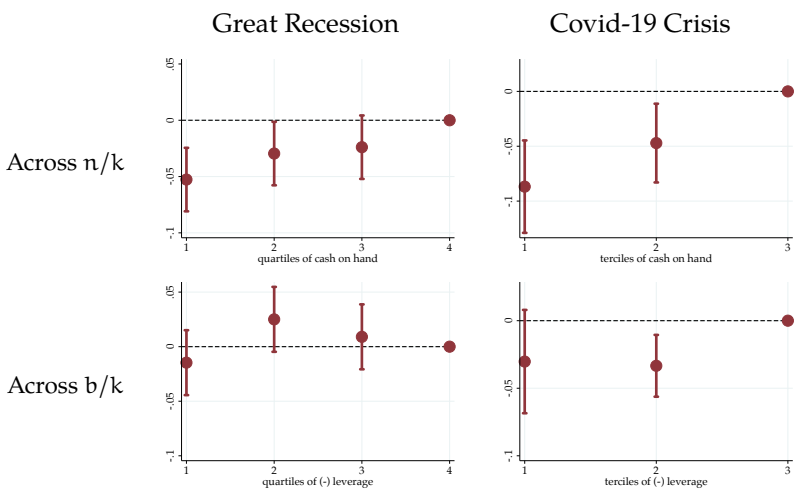




$$\beta_h : \log(k_{it+h}) - \log(k_{it}) = \alpha_i + \beta_h \text{crisis}_t + \varepsilon_{it+h}$$

back

Investment Adjustment Heterogeneity
Recent Crisis Episodes in U.S.



back

Credit Policy Setup

- Announced unexpectedly at $t = 0$ (same period of shocks) for $T \geq 0$ periods and implemented at $j \in [0, T]$
- Eligible firms $(z, n) \in \mathcal{P}$ offer sequence of $\left\{Q_t^g(.)\right\}$
- Policy $\mathcal{P}$ and labor taxes τ fixed across time
- Budget constraint from $t \geq 1$

$$\tau w_t L_t + B_t + B_{t-1,t}^g = B_t^g + (1 + r_{t-1}) B_{t-1}$$

B_t^g amount lent, $B_{t-1,t}^g$ lent at $t-1$ and recovered at t

back

Credit Insurance Policy: First Best and Trade-off

Proposition (Credit Insurance Policy)

Assume that the government implements the credit insurance policy next period and is predictable today:

1. *First best policy:* $Q^g = \tilde{Q}$ *then no rollover risk and qualified firms indifferent between using public or private credit.*
2. *No screening: fix* z^g *such that* $Q^g = \tilde{Q}\left(z^g, k', b'\right)$ *with firms qualified for credit those with* $0 > n > \underline{n}(z^g)$*. This policy faces a trade-off between lowering firm rollover risk and greater misallocation.*

- 1st best policy eliminates rollover crises and firms don't use the program's credit
- W/o screening greater z^g will preclude more rollover crises, but firms with $z < z^g$ will draw funds (zombification)

back trade-off

Direct Lending vs. Credit Guarantees

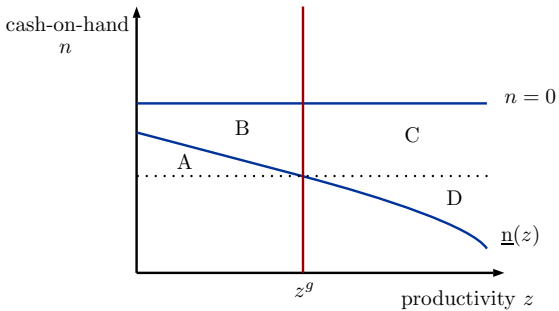
- Examples: direct lending ≈ Fed's PMCCF SMCCF and credit guarantee ≈ PPP
- In the theory policies are
  - direct lending (DL): alternative $Q^g(.)$ detail theory
  - credit guarantee (CG): repay $\alpha_g^r \geq \alpha^r$ in case of default
- Workings relative to rollover crises
  - DL affects payoffs (outside eq) and could coord creditors in good eq
  - CG relaxes $\underline{n}(z)$ but doesn't *directly* preclude rollover crises

back

Credit Policy Trade-off

Stylized example of 1 period policy in PE and two extreme cases

1. *Perfect screen of* z : $Q^g = \tilde{Q}$ and then remove coord failures for "free"
2. *No screen of* z : gov lends to elegible firms $n \in (0, \underline{n}(z^g)]$ firms at $\tilde{Q}(z^g, k', b')$, with z^g parameterizing policy scope



A ∪ B ∪ C: elegible

D: excluded

A ∪ B: subsidized credit

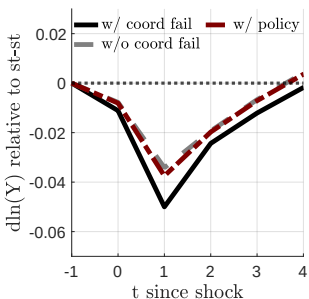
B ∪ C: rollover crises precluded

back proposition

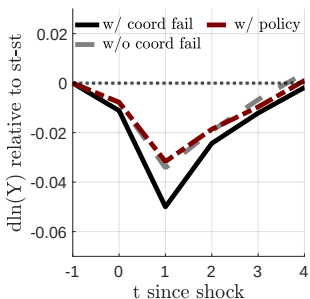
Credit Policy Implications: cash shock

- Policy active for first two periods and TFP shock driven crisis back cash shock results

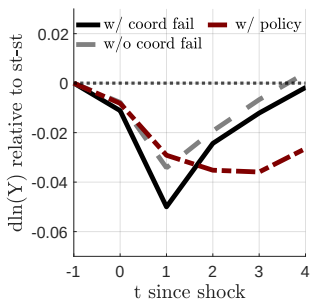
low scale



medium scale



large scale

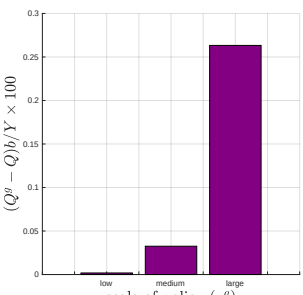


Credit Policy Implications: TFP shock

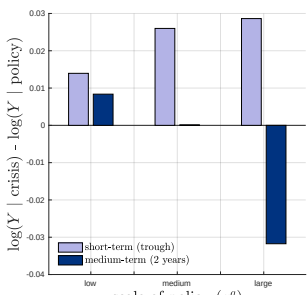
- Compute fiscal costs, short and long term benefits back

Costs and benefits

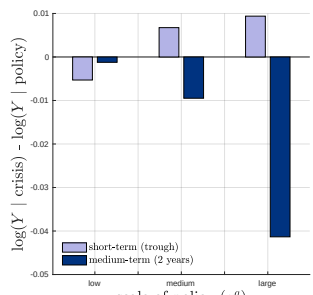
Fiscal costs



Benefits with roll crises



Benefits without roll crises



Liability Structure Data

- Debt maturity (Compustat)

	Time to mature (share)		
	< 1 year	1 to 4 years	≥ 5 years
Debt	0.29	0.33	0.38
	< 1 year	> 1 years	
Liabilities	0.61	0.39	

- Number of creditors from bankruptcy filings to Chapter 11 (FJC-IDB)

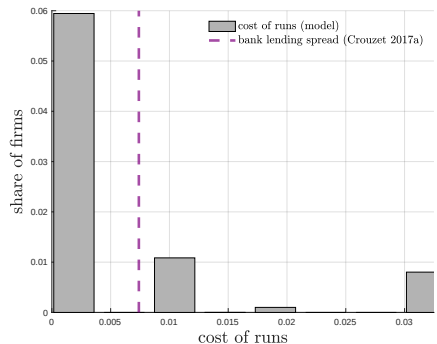
	# Creditors		
	1 to 100	101 to 1,000	>1,000
Medium (> 50 million and < 1 billion assets)	0.16	0.19	0.65
Large (> 1 billion assets)	0.03	0.04	0.93

back

How Costly are Firms' Rollover Crises?

- (ex-ante) Cost computed as $\tilde{Q}\left(z, k', b'; \eta\right) - \tilde{Q}\left(z, k', b'; 0\right)$
- Only 2.2% of the firms face a cost of rollover risk higher than intermediation spread

Cost of rollover crises (in annual spread terms) distribution



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