Financial Theory IV: Macrofinance I, Firms

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Spring 2025

Overview

- Key questions:
  - What frictions are relevant for firm financial structure?
  - How do these frictions influence the transmission of shocks?
  - What shocks have driven output, investment, and employment at the macro level?
  - What happens to firm credit in bad times?
- Today's plan:
  1. Financial frictions in macroeconomic models.
  2. Institutional detail (i): debt covenants.
  3. Institutional detail (ii): credit lines.

Part I: Financial Frictions

Frictionless Benchmark

- Firm maximizes

$$V_t(B_{t-1}, K_{t-1}) = \max_{D_t, B_t, L_t, K_t} D_t + \beta E_t \left[\Lambda_{t+1} V_{t+1}(B_t, K_t)\right]$$

subject to

$$D_t \leq (1-\tau)\Big[F(K_{t-1}, L_t) - W_t L_t\Big] + B_t - R_{t-1} B_{t-1} - Q_t\Big[K_t - (1-\delta)K_{t-1}\Big].$$

- FOCs:

$$\begin{aligned}
(L_t): &\quad F_{L,t} = W_t \\
(K_t): &\quad Q_t = E_t\left\{\Lambda_{t+1}\Big[(1-\tau)F_{K,t+1} + (1-\delta)Q_{t+1}\Big]\right\} \\
(B_t): &\quad 1 = R_t E_t\Big[\Lambda_{t+1}\Big].
\end{aligned}$$

- How much debt should the firm take on?

Townsend (1979 JET)

- Take a step back: why do we observe debt in the first place?
  - First-best contracts would likely imply repayment schedule $g(y)$ that depends on output y.
- Townsend's answer: **costly state verification**.
  - Creditors can't verify output of firm without paying cost.
- What do the resulting contracts look like? **Risky debt!**
  - In region with no verification, borrower pays constant $\bar{C}$.
  - In region with verification, borrower pays $g(y) < \bar{C}$.
- Optimal contract when lender risk neutral: borrower payoff $y - g(y)$ is constant over verification region (i.e., seize firm).

Bernanke, Gertler, Gilchrist (1999)

- Impose Townsend (1979 risky debt) when firm faces stochastic return on capital.
  - Output of K_{t-1} units of capital at time t: $\omega_{it} R_t^k Q_{t-1} K_{t-1}$, $\omega_{it} \overset{iid}{\sim} F(\omega)$.
  - Risky debt contract requires firm to repay $Z_{t-1} B_{t-1}$.
- Firm repays if and only if

$$\omega_{it} > \bar{\omega}_t = \frac{Z_{t-1} B_{t-1}}{R_t^k Q_{t-1} K_{t-1}}.$$

- Payoff to firm: $\left(\int_{\bar{\omega}_t} \omega \, dF(\omega) \right) R_t^k Q_{t-1} K_{t-1} - Z_{t-1} B_{t-1} \big(1 - F(\bar{\omega}_t)\big)$.
- Participation constraint for lender:

$$Z_t B_t \big(1 - F(\bar{\omega}_{t+1})\big) + (1 - \mu) \left(\int^{\bar{\omega}_{t+1}} \omega \, dF(\omega) \right) R_{t+1}^k Q_t K_t \geq R_t^f B_t$$

Bernanke, Gertler, Gilchrist (1999)

- Key assumption: firm cannot issue equity.

$$
\begin{aligned}
B_t &= Q_t K_t - N_t \\
N_t &= \gamma V_t + W_t^e \\
V_t &= \left(\int_{\bar{\omega}_t} \omega \, dF(\omega) \right) R_t^k Q_{t-1} K_{t-1} - Z_{t-1}(Q_{t-1} K_{t-1} - N_{t-1}) F(\bar{\omega}_t)
\end{aligned}
$$

  where $1 - \gamma$ is exit rate, N_t is net worth, W_t^e is entrepreneurial labor income.

- Firm pays dividends only on exit.
- Why? Returns on inside equity exceed risk-free rate.

Bernanke, Gertler, Gilchrist (1999)

- Firm optimality subject to participation constraint implies $K_t = \psi(s_t)N_t$, where s is spread between internal and external funds R^k/R.
- Structure leads to **financial accelerator** where firm financing amplifies shocks.
- PE effect: leverage $\implies$ positive shocks to R^k_t increase N_t and K_t more than one-for-one.
- GE effect: increased investment pushes up the price of capital, increasing net worth further.
  - Due to standard "Q" theory logic ($i_t = I_t/K_{t-1}$):

$$K_t = \Big(1 - \delta + \Phi(i_t)\Big)K_{t-1}$$
$$Q_t = \Phi'(i_t)^{-1}.$$

Bernanke, Gertler, Gilchrist (1999)

- Amplification of monetary policy (boost to firm demand).

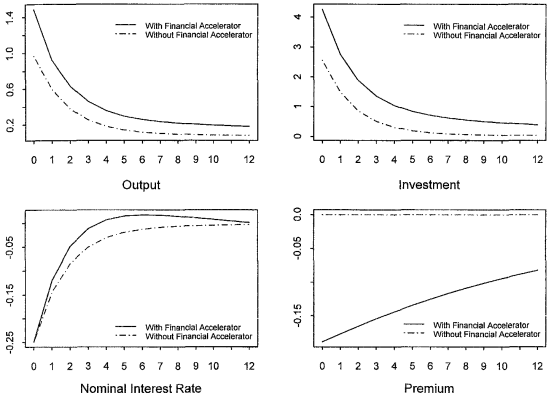


Fig. 3. Monetary shock – no investment delay. All panels: time horizon in quarters.

Bernanke, Gertler, Gilchrist (1999)

- Amplification of other shocks.
- What is a crisis? Bad firm return ... loss of entrepreneur wealth

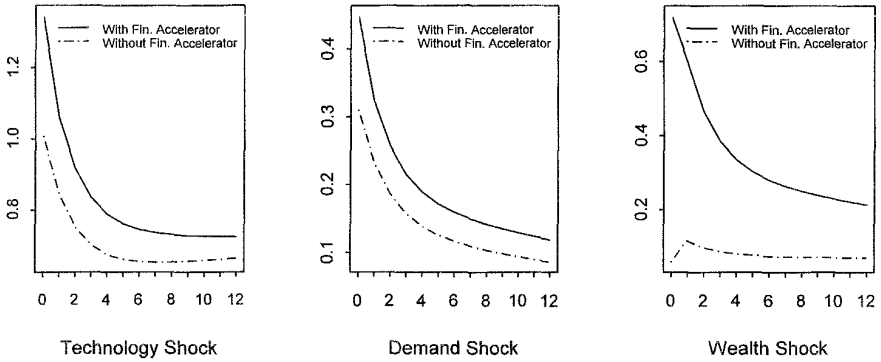


Fig. 4. Output response – alternative shocks. All panels: time horizon in quarters.

Christiano, Motto, Rostagno (2014 AER)

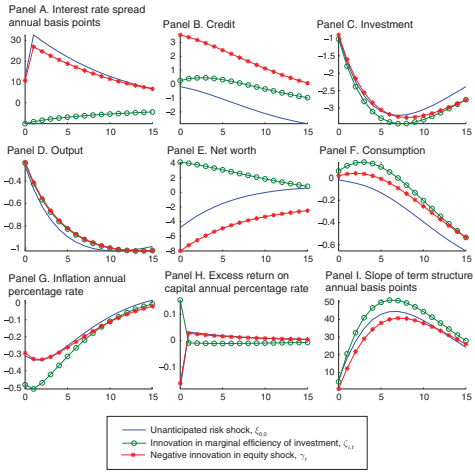
- BGG: (constant) risk of default $\implies$ amplification of shocks that influence borrower equity.
- CMR: what about movements in the risk of default itself? **Risk shocks**.
  - Make volatility of ω_{it} itself a time-varying process: $\sigma_{\omega,t}$.
- Estimate DSGE model including risk shocks.
  - Main finding: risk shocks explain 62% of output growth fluctuations since mid-1980s.

Christiano, Motto, Rostagno (2014 AER)

- How do we know these are really risk shocks? Compare to alternatives.
- Shocks to marginal efficiency of investment (Justiniano, Primiceri, Tambalotti 2010 JME).
  - Also imply response of capital demand.
  - But these shocks imply that market value of capital (stock market) is countercyclical.
  - Why? Fall in replacement cost lowers value of installed capital.
- Aggregate shocks to net worth.
  - Also creates fall in investment, output.
  - But implies that credit is countercyclical!
  - Why? Temporarily suppresses capital price $\implies$ high future returns $\implies$ low risk.
- Including financial data (stock value, credit spread) key for estimation.

Christiano, Motto, Rostagno (2014 AER)

- Comparison of shocks in CMR.



Christiano, Motto, Rostagno (2014 AER)

- Without stock market data, would estimate MEI shock as key driver instead of risk.

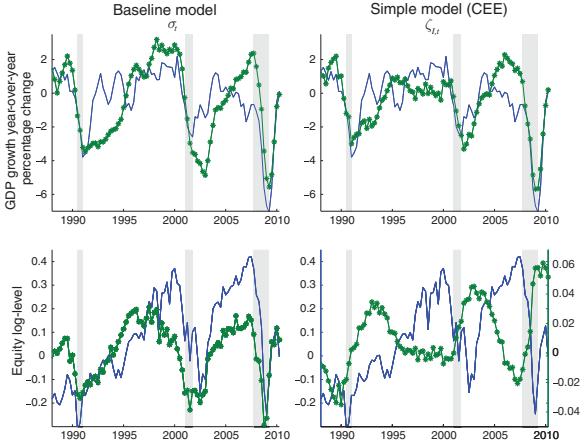


FIGURE 5. HISTORICAL DECOMPOSITIONS IN TWO MODELS

Risk Shocks vs. Financial Shocks

- Why do risk shocks matter in CMR? Increase credit spreads.
  - But financial shocks that reduce supply of corporate debt could have the same effect.
- Gilchrist and Zakrajsek (2012 AER):
  - Define **excess bond premium** (EBP) to be credit spreads **orthogonalized** to expected defaults.
  - Find that EBP predicts declines in economic activity and asset prices.
  - Reflects reduced risk-bearing capacity by the financial sector.
- Gilchrist, Sim, and Zakrajsek (2014):
  - Does uncertainty matter beyond financial shocks? Yes!
  - But only matters to the extent that it influences credit spreads.
  - Real options ("wait and see") effects not important.
- Takeaway: true "risk" shocks as well as general financial shocks important drivers.

Jermann and Quadrini (2012 AER)

- Papers discussed until now assume firms financed by debt and inside equity.
- In reality, firm equity financing is not only prevalent, but displays strong cyclicality.
  - Net equity payout (dividends + repurchases) and net debt repurchases negatively correlated.
  - In expansions, firms tend to increase net equity payout (dividends + repurchases).
  - In recessions, firms tend to pay down debt.
- Need a way to break Modigliani-Miller: tax shield on debt.

Jermann and Quadrini (2012 AER)

- **Model feature #1**: dividend (payout) cost:

$$\varphi(D_t) = D_t + \kappa(D_t - \bar{D})^2.$$

  where negative dividends correspond to equity issuance.

- Implication for firm SDF:

$$\Lambda_{t+1}^{Firm} = \Lambda_{t+1}^{HH}\left(\frac{\varphi'(D_{t+1})}{\varphi'(D_t)}\right) = \Lambda_{t+1}^{HH}\left(\frac{1-\kappa(D_{t+1}-\bar{D})}{1-\kappa(D_t-\bar{D})}\right)$$

- Provides link between debt financing and real investment.
  - Without this, firm with additional access to debt would take advantage of tax shield, but just pay out proceeds to shareholders.
  - With payout friction, firm incentivized to invest newly borrowed funds.

Jermann and Quadrini (2012 AER)

- **Model feature #2**: limited enforcement
  - Lender can only seize firm's capital, not current revenues.
  - Limited enforcement: lender can only recover capital with probability ξ_t.
  - Expected renegotiation process leads to enforcement constraint

$$\xi_t \left(K_t - \frac{B_t}{1 + r_t} \right) \geq F(K_{t-1}, L_t)$$

- ξ_t is stochastic, source of financial shocks.
- Similar to working capital constraint: ability to produce depends on borrowing capacity.
  - After negative financial shock, firm needs to either cut dividends or employment.
  - Dividend smoothing $\implies$ employment responses strongly linked to financial shocks.

Jermann and Quadrini (2012 AER)

- Obtain TFP shock as Solow residual, financial shocks directly from enforcement constraint.

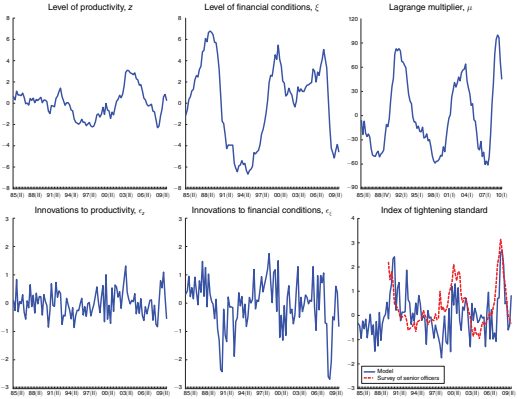


FIGURE 2. TIME SERIES OF SHOCKS TO PRODUCTIVITY AND FINANCIAL CONDITIONS

Jermann and Quadrini (2012 AER)

- Even with financial friction, TFP shocks can't explain much.

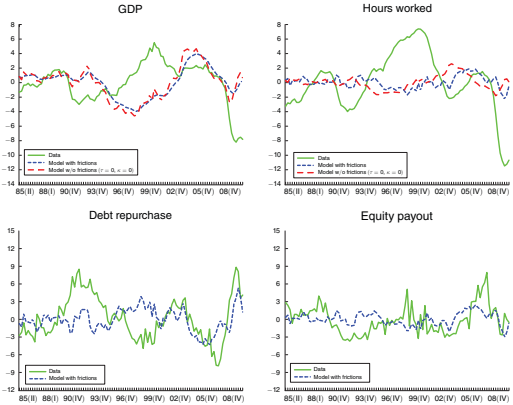


FIGURE 3. RESPONSE TO PRODUCTIVITY SHOCKS ONLY

Jermann and Quadrini (2012 AER)

- Instead, financial shocks end up doing a lot of the lifting.

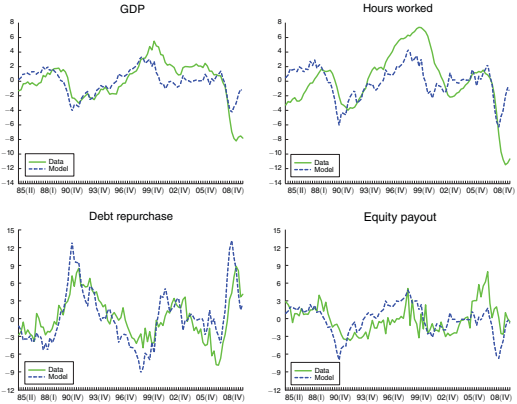


Figure 4. Response to Financial Shocks Only

Part II: Debt Covenants

Background: Debt Covenants

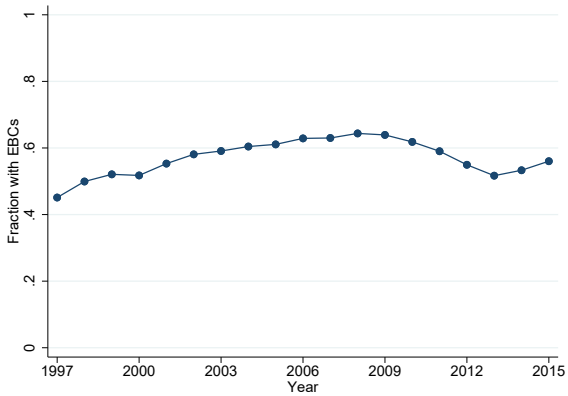
- Covenants provide conditions that, if violated by the firm, allow lender to demand immediate repayment ("technical default").
  - Often set thresholds for financial ratios $\implies$ debt limits.
  - Applies to entire firm's statistics, not limited to individual loan.
  - Violation typically leads to (costly) renegotiation.

- Three main types:
  1. **Interest Coverage (IC):** restrict interest payments $\leq$ fraction θ^{IC} of earnings (EBITDA).
  2. **Debt/Earnings (DE):** restrict stock of debt $\leq$ fraction θ^{DE} of earnings (EBITDA).
  3. **Leverage:** restrict stock of debt $\leq$ fraction θ^{LEV} of firm book value.

Lian and Ma (2021 QJE)

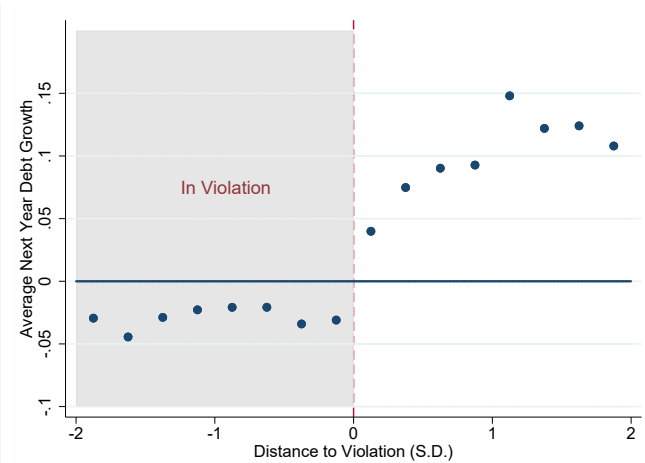
- Most lending secured by firm's future cash flows, not by specific physical assets.
- Covenants typically "earnings-based" (EBCs) when firm earnings sufficiently reliable.

Panel B. Fraction of Firms with Earnings-Based Covenants



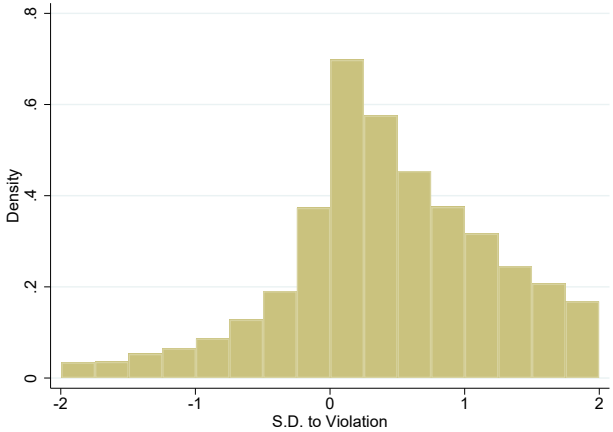
Lian and Ma (2021 QJE)

- Firms appear cut off from debt after violation, as in e.g., Roberts and Sufi (2009 JF).



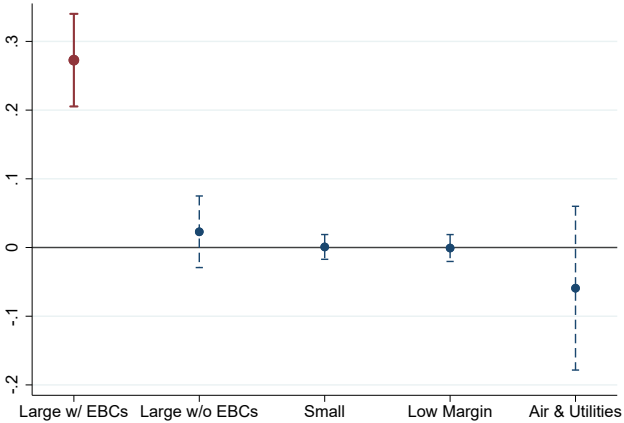
Lian and Ma (2021 QJE)

- Precautionary motive may also drive debt dynamics even without violation.



Lian and Ma (2021 QJE)

- Regression specification: $Y_{it} = \alpha_i + \eta_t + \beta \text{EBITDA}_{it} + \kappa \text{CashFlow}_{it} + X'_{it}\gamma + \epsilon_{it}$.
- EBITDA is an accounting fiction, but is important driver of debt and investment, even after controlling for c
- Little effect for f ily liquidated capital.
- Confirmed by IV



Lian and Ma (2021 QJE)

- Does distinction between EBCs and financial accelerator matter?
- In crisis, EBCs decouple asset values and borrowing capacity (vs. collateral constraint).
- Compare borrowing to firm real estate

$$Y_{it} = \alpha_i + \beta RE_{it} + X'_{it}\gamma + \epsilon_{it}$$

- Under collateral constraint, firms should be very sensitive to drop in RE value.
  - Find small responses, concentrated in asset-based lending (i.e., mortgages).
  - Conclude little effect of real estate crash on firm borrowing (unlike Japanese case).
- Drop in EBITDA very important, explaining 10-15% of issuance decline among public firms, 8-10% of decline in CapEx.

Chodorow-Reich and Falato (2022 JF)

- Why didn't long-term debt protect firms from financial shocks? Covenant violations.
  - Allowed accelerated deleveraging: only 10% of bank loans had maturity < 1 year at start of crisis.
  - Lots of firms ($\sim 1/3$ per year) violate covenants, mostly due to falling earnings.
  - But $\sim 1/4$ of firms violate in a typical year. What changed?
- Answer: **lender health**.
  - Measure lender health based on counterparty risk and mortgage-related writedowns.
  - Reduction in loan commitment 24ppt more likely for least vs. most healthy lenders.
  - Overall, accounts for 11% decline in loans and commitments during the crisis.
  - Borrowers unable to substitute, reduce investment and employment.
- What is a crisis? Large financial shock **+ ability to accelerate repayment through covenants**.

Case Study:
Firm Debt Covenants and the Macroeconomy: The Interest Coverage Channel

Motivation

- Non-residential investment is a key driver of monetary policy response.
  - Natural link: $10T corporate debt market.
  - Large body of work on transmission through credit limits ("financial accelerator").
- Firm credit limits typically modeled as caps on market leverage.
  - But actual covenants observed in debt contracts are quite different.
  - Lian and Ma (2019): importance of earnings based constraints.
  - But many covenants depend on more than earnings, firms often have several at once.
- **Research question:** how does firm credit limit structure influence macro dynamics?
  - Focus on **Interest Coverage (IC)** covenants that limit ratio of interest payments to earnings.

Firm Debt Covenants and the Macroeconomy

- **Approach**: combine structural model with firm-level empirical evidence.
- **Stylized Facts**: Interest Coverage covenants extremely common (seen in 84% of firms in DealScan sample with covenants), maximum ratios appear stable over time.
- **Main Finding #1**: Interest Coverage covenants amplify interest rate transmission.
  - Much stronger responses of debt, investment, output than under alternative covenant types.
  - Reason: implied limits directly shifted by interest rates.
  - Data: $r_t \downarrow$ 100bp $\implies$ extra 9.5% 8Q asset growth for firms with IC covenants only.
- **Main Finding #2**: Combination of IC + limit on stock of debt $\implies$ state dependence.
  - Stronger transmission when rates are already high (and IC covenants are tighter).
  - Estimated share with IC as tightest covenant varied from 7% to 60% over 1997-2007 period.
  - Data: $r_t \downarrow$ 100bp $\implies$ extra 2.1% 8Q asset growth for firms w/ these covs when r_{t-1} 100bp higher.

Background: Debt Covenants

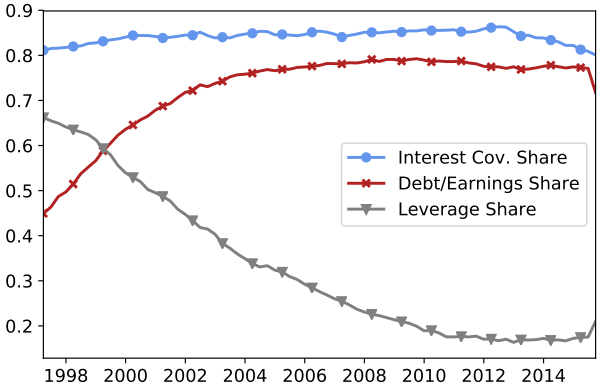
- **Covenants:** provide conditions that, if violated by the firm, allow lender to demand accelerated repayment.
  - Often set thresholds for financial ratios $\implies$ debt limits.
  - Ratios computed using total firm statistics, checked throughout life of loan.
  - Violation typically leads to (costly) renegotiation.
- **Purpose:** help firm commit not to overlever on other loans, provide "tripwires" for lender to reassess investment, seize control rights.
- Three main types:
  1. **Interest Coverage (IC):** restrict interest payments $\leq$ fraction θ^{IC} of earnings (EBITDA).
  2. **Debt/Earnings (DE):** restrict stock of debt $\leq$ fraction θ^{DE} of earnings (EBITDA).
  3. **Leverage:** restrict stock of debt $\leq$ fraction θ^{LEV} of firm book value.

Simple Example of Interest Rate Transmission

- Consider firm with no debt, EBITDA $10M, max ratio of interest to EBITDA of 40%.
  - Max interest payment is $4M.
  - At 6% interest rate, firm can borrow up to $4M / 0.06 = $66.7M without violating.
  - If rates fall to 5%, firm can now borrow $4M / 0.05 = $80M, an increase of 20%
- This high sensitivity can hold even if firm uses only fixed-rate debt.
  - In this case, relevant interest rate is rate on **new** fixed rate debt.
  - Number of dollars of **new** debt firm can take on without violating has same high elasticity.
- When firm has existing floating-rate debt, **total** debt capacity sensitive to rates.
  - Share of interest cap consumed by existing debt also varies with rates.
  - Can violate covenant limit even without taking on new debt.

Covenant Prevalence by Type

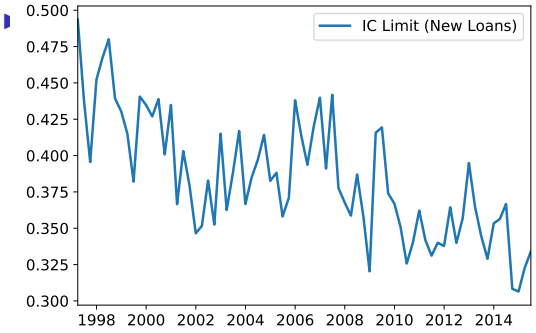
- Plot: share with each covenant type for firms with at least one DealScan covenant.
- Share with Interest Coverage covenant high and stable over time.



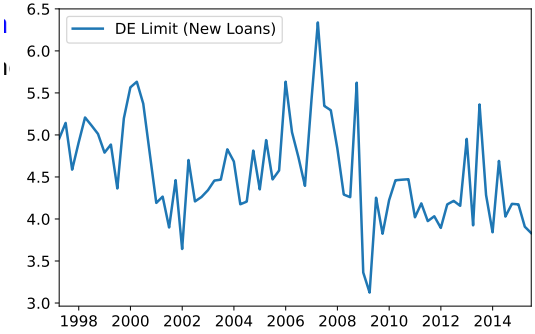
Source: DealScan. Shares are equally weighted among DealScan firms with at least one covenant.

Covenant Ratios Over Time

- Complication: covenant limits are endogenously set.
  - Do lenders simply adjust thresholds when interest rates or earnings change?



(a) Interest/EBITDA Ratio

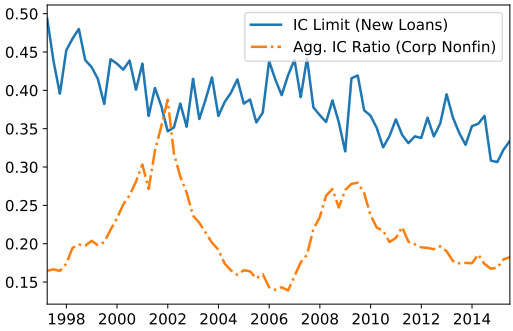


(b) Debt/EBITDA Ratio

Source: DealScan, Compustat. Limits for new loans are weighted by deal size.

Covenant Ratios Over Time

- Compare to corresponding ratios for corporate nonfinancial sector.
  - Slightly noisy, but little comovement with underlying economic fundamentals.



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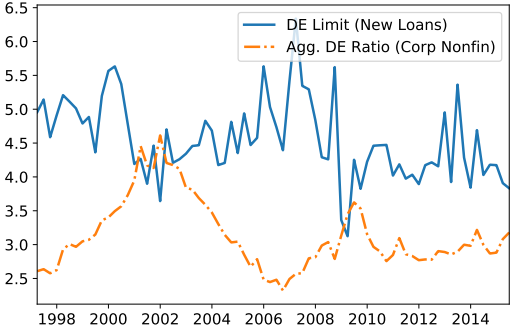
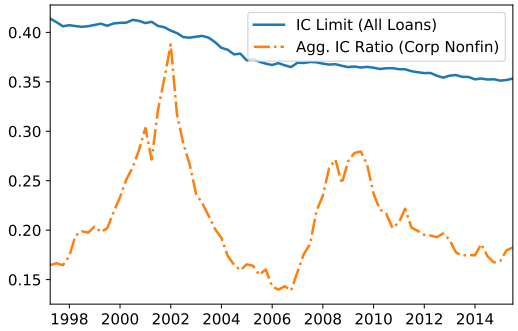


(b) Debt/EBITDA Ratio

Source: DealScan, NIPA, Flow of Funds. Limits for new loans are weighted by deal size.

Covenant Ratios Over Time

- Now look at all active covenants. Provide smooth and stable constraints over time.
  - Reasonable to consider thresholds fixed at business cycle frequency.



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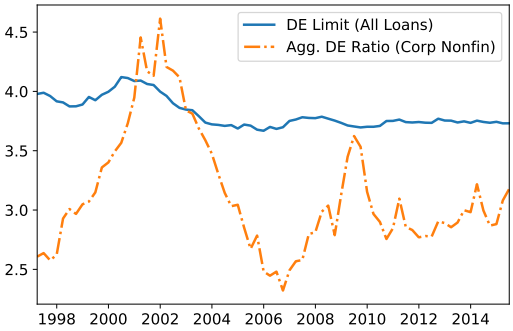


(b) Debt/EBITDA Ratio

Source: DealScan, NIPA, Flow of Funds. Limits for new loans are weighted by deal size.

Model

Model Overview

- Demographics and preferences
  - Risk-neutral representative **saver** lends to firms and provides labor: $u^S(C, N) = C - \eta N$.
  - Representative **entrepreneur** owns firms and consumes dividends: $u^E(D) = \log(D)$.
  - Interest rate variation $\implies$ time varying discount factor (both agents):

$$\log \beta_t = (1 - \rho_\beta) \log \bar{\beta} + \rho_\beta \beta_{t-1} + \varepsilon_{\beta,t}.$$

- Productive technology: $f(K_{t-1}, N_t) = Z_t K_{t-1}^{\alpha} N_t^{\gamma}$
  - Diminishing returns ($\alpha + \gamma < 1$) $\implies$ markups.
- Representative firm owns capital and pays dividends to entrepreneur.
  - Borrows in risk-free floating rate debt at rate r_t, interest is tax deductible (**tax shield**).
  - Concave entrepreneur utility $\implies$ dividend smoothing motive (**financing frictions**).
  - Combined: pathway from debt limits $\rightarrow$ debt $\rightarrow$ investment.
- Flexible prices and wages, monetary authority targets achieves inflation target.

Representative Firm's Problem

- Firm chooses dividends D_t, labor demand N_t, new debt B_t and the investment rate i_t to max

$$V^F(K_{t-1}, B_{t-1}) = D_t + E_t\left[\Lambda^E_{t+1} V^F(K_t, B_t)\right]$$

where Λ^E_{t+1} is the entrepreneur SDF, subject to the budget constraint

$$D_t = \underbrace{(1-\tau)\Big(f(K_{t-1}, N_t) - w_t N_t\Big)}_{\text{after-tax profit}} + \underbrace{\tau\delta K_{t-1}}_{\text{depreciation credit}} - \underbrace{i_t K_{t-1}}_{\text{investment}}$$
$$- \underbrace{(1-\tau) r_t \pi_t^{-1} B_{t-1}}_{\text{interest payment}} + \underbrace{\left(B_t - \pi_t^{-1} B_{t-1}\right)}_{\text{net principal}}$$

and the borrowing constraint (debt covenants).

Covenant Implementations

- Denote EBITDA by $X_t = f(K_{t-1}, N_t) - w_t N_t$.
- Covenant types (for simplicity, imposed as hard caps):
  1. **Interest Coverage:** $\bar{B}_t^{IC} = \dfrac{\theta^{IC} X_t}{r_t}$.
  2. **Debt/Earnings:** $\bar{B}_t^{DE} = \theta^{DE} X_t$.
  3. **Leverage:** $\bar{B}_t^{LEV} = \theta^{LEV} BV_{t-1} \simeq \theta^{LEV} K_{t-1}$.
- Only Interest Coverage **directly shifted** by interest rates.
  - Highly sensitive, semielasticity of $\bar{B}^{IC}$ to rates ~ 16.
- Overall debt limit is smoothed to allow for e.g., annual financial statistics:

$$B_t \leq \rho \bar{B}_t + (1-\rho)\pi_t^{-1} B_{t-1}$$

Collateralizability

- Additional channel (beyond financial friction) linking covenants and investment.
- Optimality condition for investment:

$$\underbrace{\Phi'(i_t)}_{\text{Marginal Cost}} = \underbrace{\Omega_t}_{\text{Value of CFs}} + \underbrace{\mathcal{M}_t E_t\left[\frac{\partial \bar{B}_{t+1}}{\partial K_t}\right]}_{\text{Collateral Benefit}}$$

- Key object is **collateralizability** of investment: $\partial \bar{B}_{t+1}/\partial K_t$:

$$\frac{\partial \bar{B}^{IC}_{t+1}}{\partial K_t} = \frac{\theta^{IC} f_{K,t+1}}{r_{t+1}}, \qquad \frac{\partial \bar{B}^{DE}_{t+1}}{\partial K_t} = \theta^{DE} f_{K,t+1}, \qquad \frac{\partial \bar{B}^{LEV}_{t+1}}{\partial K_t} = \theta^{LEV}.$$

- All covenants are collateralizable, but only IC collateralizability varies with interest rate.

Data and Calibration

- Data: merged Dealscan (syndicated loan covenants) and Compustat (firm data).
  - Sample: 1997 to 2007.
  - Drop finance + real estate, public utilities, public administration, mining, construction.
  - Assume firm has covenant until loan matures, unless EBITDA negative.
- Restrict sample to firms with above-quarter-median assets and profit margin.
  - These are the firms likely able to sustain earnings based covenants (Lian and Ma, 2018).
  - Comprises 29% of firms, but 67% of sales.
  - 60% of this sample has at least one active Dealscan covenant in a given quarter.
- Calibration:
  - Target debt limits $\theta^{IC}, \theta^{DE}, \theta^{LEV}$ to match observed debt/EBITDA ratios by type.
  - Set discount rate to target interest rate of 6.11% (248bp spread over T-Bill).

Firm Characteristics by Covenant

- Firms with covenants larger, more levered than firms without covenants/syndicated loans.
- Firms with IC + DE covs largely similar. Firms with Leverage covenants a bit smaller.

	None	IC	DE	Lev	IC + DE	IC Only	DE Only
Sales	10.45	138.73	135.58	82.47	141.42	156.76	112.61
EBITDA	0.33	18.56	18.71	8.65	20.66	16.40	11.16
Assets	50.53	508.75	514.35	290.40	543.38	545.63	432.43
Debt	2.41	142.74	151.34	54.05	161.62	201.07	150.00
ST Debt	0.49	5.00	5.37	3.37	5.09	7.47	10.26
LT Debt	0.70	125.00	133.86	38.87	146.63	180.98	119.70
Cash	7.42	16.93	17.07	14.14	17.59	17.05	16.54
Debt/EBITDA	0.00	7.89	8.08	5.43	8.04	11.98	9.60
Debt/Assets	0.114	0.289	0.299	0.225	0.301	0.339	0.321
EBITDA/Assets	0.013	0.036	0.036	0.031	0.037	0.029	0.029
Market-to-Book	1.54	1.15	1.16	1.12	1.19	1.03	1.01
N	99,669	36,522	29,132	24,237	24,401	4,137	3,334

Statistics are equal-weighted medians. Source: Dealscan, Compustat.

Firm Characteristics by Covenant (Selected Sample)

- Differences much more muted in selected (high-asset, high-margin) sample.

	None	IC	DE	Lev	IC + DE	IC Only	DE Only
Sales	172.37	196.75	182.88	225.76	180.72	243.32	210.25
EBITDA	24.42	28.08	27.35	28.14	27.80	26.59	23.79
Assets	574.59	691.63	668.32	699.31	668.53	796.01	714.71
Debt	94.85	215.66	215.93	163.44	214.71	338.10	252.44
ST Debt	5.50	7.10	7.17	8.03	6.43	12.00	16.17
LT Debt	70.03	196.11	194.93	141.00	196.60	298.70	201.31
Cash	61.90	25.52	24.07	30.83	23.71	28.73	28.02
Debt/EBITDA	3.61	7.77	7.96	5.97	8.01	11.16	8.42
Debt/Assets	0.175	0.307	0.315	0.243	0.320	0.373	0.310
EBITDA/Assets	0.043	0.040	0.040	0.039	0.040	0.034	0.035
Market-to-Book	1.61	1.27	1.28	1.24	1.30	1.15	1.19
N	18,131	20,881	17,271	10,339	15,143	2,007	1,582

Statistics are equal-weighted medians. Source: Dealscan, Compustat.

Calibration (Quarterly)

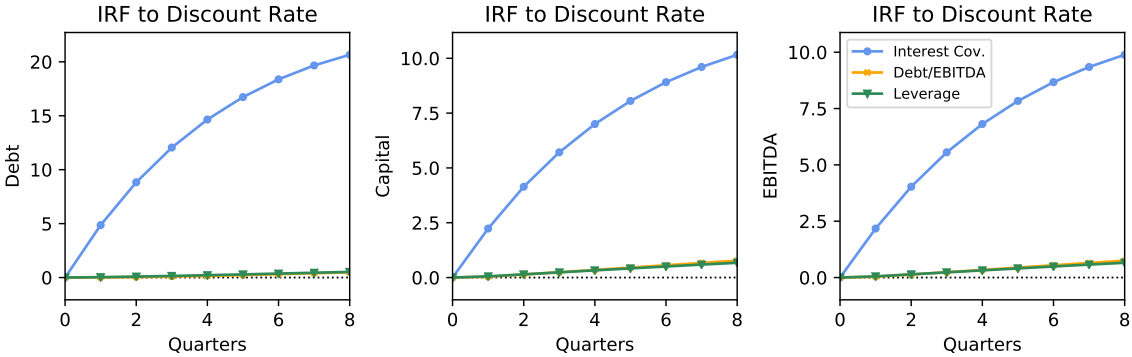
- Calibrate debt thresholds to match median debt/EBITDA ratios.
- Low calibrated debt limits equivalent to constant precautionary buffer.

Parameter	Name	Value	Internal	Target/Source
Discount factor mean	$\bar{\beta}$	0.990	N	Typical Dealscan rate
Discount factor persistence	ρ_β	0.969	N	Autocorr. of 3-Mo T-Bill
Tax rate	τ	0.350	N	Corporate tax rate
Inflation rate	$\bar{\pi}$	1.005	N	2.03% inflation
Capital share	α	0.360	N	Standard
Labor Share	γ	0.630	N	1% Markup
Depreciation	δ	0.025	N	Standard
Borrowing limit smoothing	ρ_B	0.250	N	Annualized ratios
Max interest coverage ratio	θ^{IC}	0.169	Y	Debt/EBITDA = 11.16
Max debt-to-earnings ratio	θ^{DE}	8.548	Y	Debt/EBITDA = 8.42
Max Leverage ratio	θ^{LEV}	0.227	Y	Debt/EBITDA = 5.42

Results

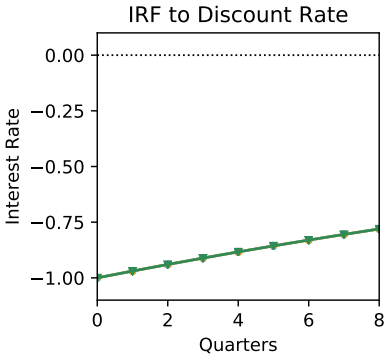
Comparison: Covenant Types

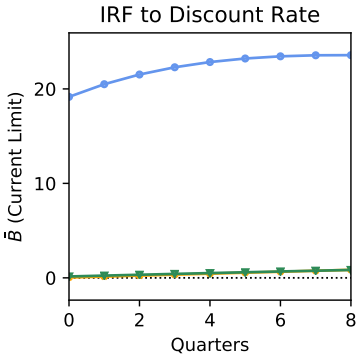
- **Main Result #1**: Interest Coverage covenants amplify interest rate transmission.
- Compare linearized IRF to $\downarrow$ 100bp disc. rate shock to firms each with single covenant.

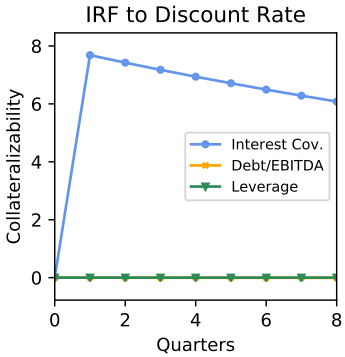


Comparison: Covenant Types

- Debt limit jumps on impact in IC economy, then drifts up due to higher EBITDA.
- Collateralizability effect $\implies$ extra 8 cents debt per dollar of investment.

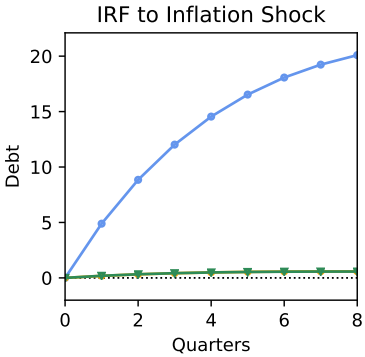


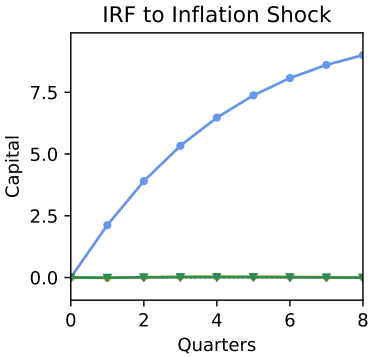


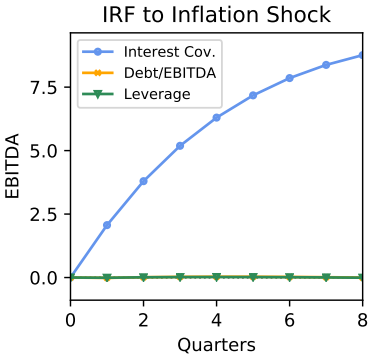


Comparison: Covenant Types, Inflation Shock

- Note: constraint is on **nominal** interest payments. Not inflation neutral!
- Shock $\log \pi_t$ 100bp $\downarrow$ with same persistence.
  - Similar 8Q growth of debt (20.1%), assets (9.0%) for IC-constrained firms as for real rate shock.







Empirical Approach

- Main specification:

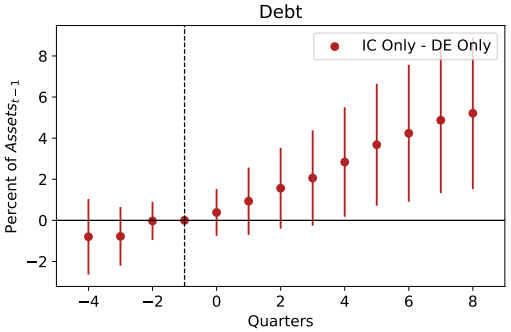
$$y_{i,t+h} = \alpha_i + \phi_{\text{ind},t} + \sum_{\text{cov}} \mathbb{I}_{\text{cov},t} \cdot (\beta_{\text{o,cov}} + \beta_{1,\text{cov}} \Delta r_t) + \gamma' X_{i,t-1} + \delta' (X_{i,t-1} \cdot \Delta r_t) + \varepsilon_{i,t}$$

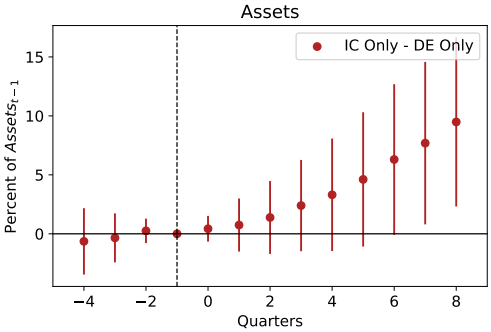
  where r_t is 3-Month T-Bill, outcome $y_{i,t+h}$ and controls $X_{i,t-1}$ are scaled by $Asset_{i,t-1}$.

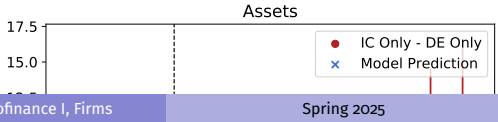
- Challenge #1: Interest rate changes are not exogenous (identified MP shocks too weak).
  - Industry-time (SIC-2) effects attempt to control for endogeneity of interest rate.
- Challenge #2: covenants (and syndicated loans) are not randomly assigned.
  - Interact Δr_t and controls
  - Directly compare firms with IC and DE covenants.

Empirical Evidence: Covenant Types

- Plots: difference in response to $r \downarrow$ 100bp between IC-Only, DE-Only: $-\left(\beta_{1,IC} - \beta_{1,DE}\right)$.
- IC-Only show additional 8Q growth in debt (5.2%), assets (9.5%) as share of $Assets_{t-1}$.

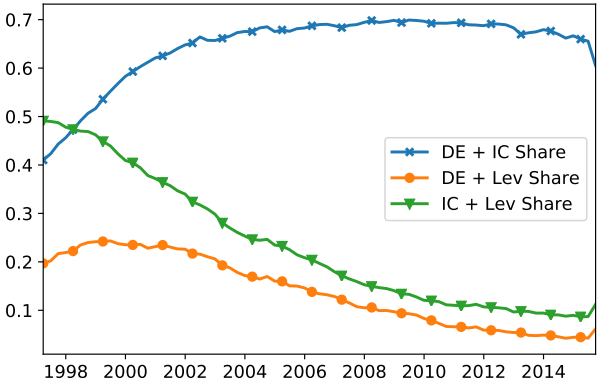






Multiple Covenants

- Previous analysis considers economies with a single covenant at a time.
- Data: most firms with any covenants have **both** Interest Coverage + Debt/Earnings.



Source: DealScan. Shares are equally weighted among DealScan firms with at least one covenant.

Implementation: Interest Coverage + Debt/Earnings Covenant

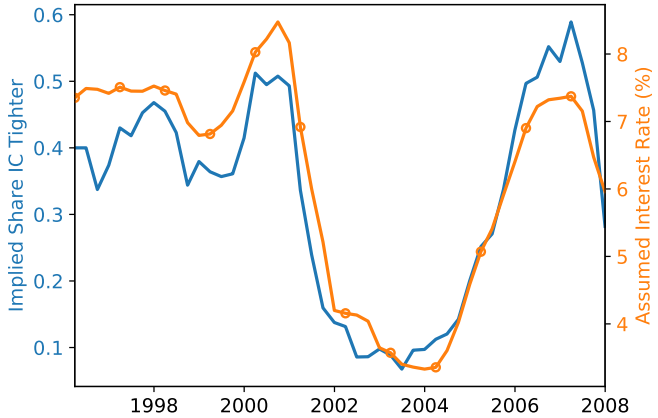
- Assume common Debt/Earnings limit $\bar{\theta}^{DE}$, but each firm i faces idiosyncratic IC limit:

$$\theta_{i,t}^{IC} = e_{i,t}\bar{\theta}^{IC}, \qquad \log e_{i,t} \overset{iid}{\sim} N\left(-\frac{1}{2}\sigma_e^2,\ \sigma_e^2\right)$$

- Calibrate σ_e to match IQR of $\log(\theta_{i,t}^{DE}/\theta_{i,t}^{IC})$ in DealScan data. ($\sigma_e = 0.301$).
- Timing:
  - Firm re-draws $e_{i,t}$ each time it takes on new debt.
  - Must choose capital before it knows its draw of $e_{i,t}$.
- Overall debt limit: $\bar{B}_{i,t} = \min\left(\bar{B}_{i,t}^{IC}, \bar{B}_{i,t}^{DE}\right)$.
- Whether Interest Coverage or Debt/Earnings is tighter uniquely determined by rates.
  - In the model, Interest Coverage binds if and only if $r_t \geq r_{i,t}^* \equiv \theta_{i,t}^{IC}/\bar{\theta}^{DE}$

Measuring Covenant Tightness

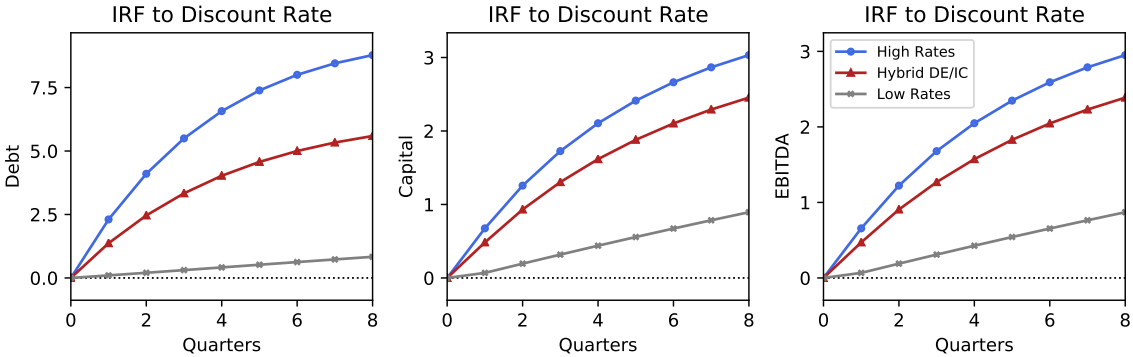
- What about in the data? Firms keep excess debt capacity to precautionarily avoid violation.
  - Compute closest covenant adjusting for differential violation risk following Murfin (2012).
- Apply to Deals tightest covenant.
  - Range fron
- Average share
  - Calibrate n



Source: DealScan, Compustat, equally weighted.

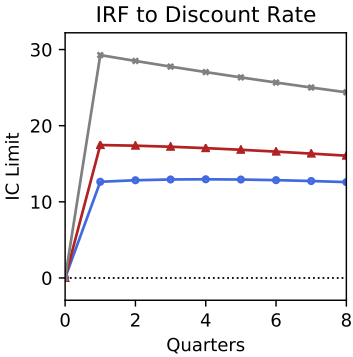
State Dependence: DE + IC Covenants

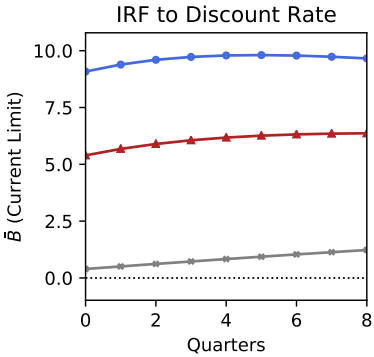
- **Main Result #2:** Combining IC + DE covs $\implies$ **state dependent** interest rate transmission.
- Alternative regimes with SS interest (discount) rate high (+250bp) vs. low (-250bp).
- Stronger transmission when rates are high (73.4% IC binds) vs. low (1.3% IC binds).

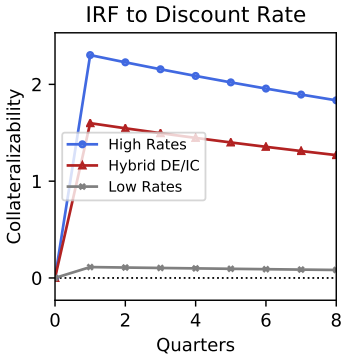


State Dependence: DE + IC Covenants

- Note: larger response under high rates despite smaller **proportional** change.
- Change in frac. IC-constrained (extensive margin) overwhelms smaller change in debt limits.



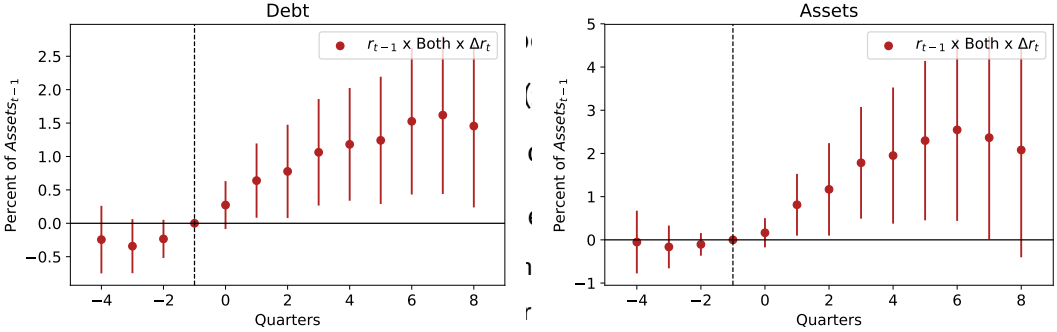




Empirics: State Dependence

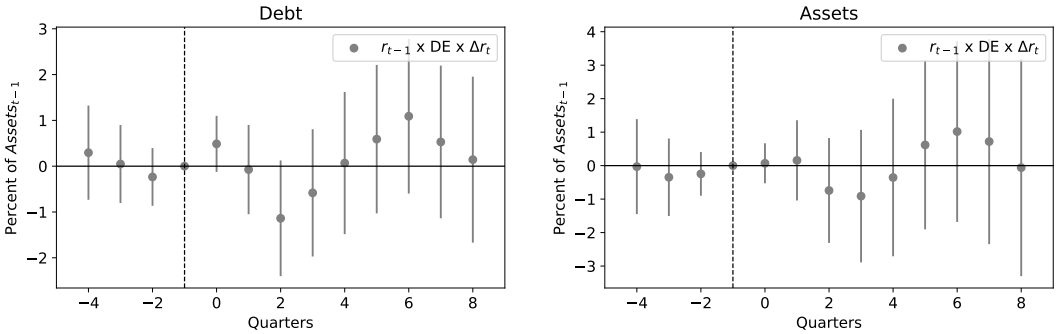
- Augment original regression so all variables are interacted with interest rate

$$y_{i,t+h} = \alpha_i + \phi_{\text{ind},t} + \sum_{s\in\{0,1\}} \left(\mathbb{I}_0 + \mathbb{I}_1 r_{t-1}\right) \left\{ \sum_{\text{cov}} \mathbb{I}_{\text{cov},t} \cdot \left(\beta^s_{0,\text{cov}} + \beta^s_{1,\text{cov}} \Delta r_t\right) + \gamma_s' X_{t-1} + \delta_s'(X_{t-1} \cdot \Delta r_t) \right\} + \varepsilon_{i,t}$$



Empirics: State Dependence

- State dependence unique to firms with debt covenants, as predicted.
- Below: no state dependent response for firms with DE covenant only.



Source: DealScan, Compustat. Error bars denote 95% confidence interval. Standard errors are double clustered at the firm and industry-time levels. The sample spans 1997Q1 to 2007Q4.

Summary: Firm Debt Covenants

- Novel model capturing key facts about corporate debt limits.
  - Interest Coverage limits are extremely common, caps stable over time.
  - Typical firm has multiple covenants.
  - Large implied variation in share with IC as tightest covenant.
- Main results:
  - Interest Coverage covenants amplify interest rate transmission (**interest coverage channel**).
  - **State dependent** transmission: stronger when rates are high.

Part III: Transmission Through Banks

Transmission Through Banks

- Smaller firms are often heavily dependent on banks for their credit.
  - Typically cannot substitute to alternative banks following credit shocks.
  - Have a high propensity to invest out of credit supply changes.
  - Combined, implies strong pathway from bank credit to real activity.
- Many institutional and regulatory details influence how this transmission works.
- Two examples from my own work:
  - Credit line facilities
  - Regulatory accounting rules

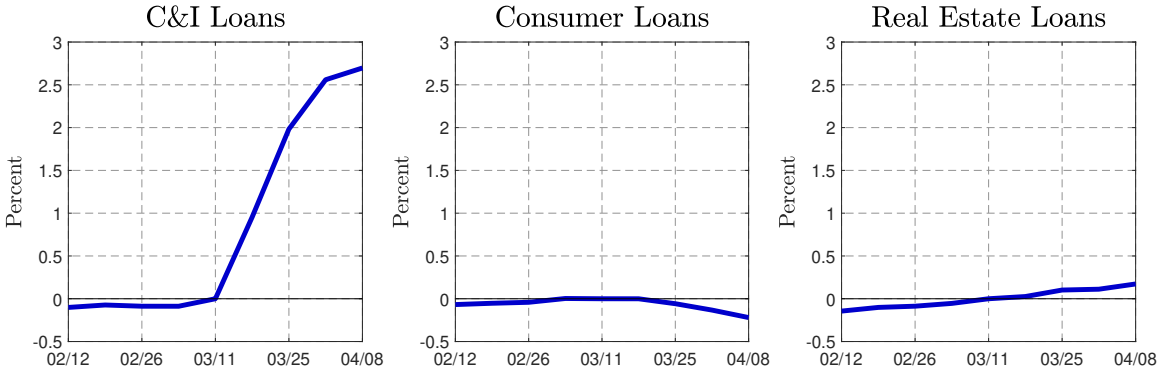
Case Study: The Credit Line Channel

Motivation

- Financial accelerator & credit channel: adverse shocks raise spreads, tighten constraints.
  - Create downward pressure on firm borrowing, worsening drop in real activity.
- Mechanisms assume lenders able to control the price and quantity of new credit.
- But importantly, not all forms of credit satisfy these conditions.
  - Key exceptions: **credit line** facilities.
  - Pledge precommited amounts of credit to borrowers at prenegotiated spread.
- Richer look at structure of corporate credit raises open questions:
  - Are credit line balances used in sufficient quantities to be important for macrofinance?
  - How are balances allocated across firms, and what does this imply about aggregates?
  - How do credit line drawdowns affect the banking sector's ability to intermediate in bad times?

Credit Movements after COVID-19 outbreak

- Acute shock: response of U.S. commercial bank credit following outbreak of COVID-19.



Source: H.8 releases for U.S. commercial banks, normalized by total assets on 3/11/2020

Motivation

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The Credit Line Channel

- **Research Question:** How does the structure of bank-firm lending influence aggregate and cross-sectional outcomes following an adverse shock?
  - Key focus on **credit lines**, which give firms access to credit at predetermined terms and pricing.
- **Approach:** Combine detailed bank-firm data with structural model.
  - Y14 stress test data: near universe of loans to firms from large US banks.
  - Structural model able to capture credit lines and realistic debt constraints.
- **Main Message:** Credit lines are essential to the transmission of shocks to firm credit.
  - Huge uncommitted balances, utilized heavily following negative shocks.
  - But cross-sectional allocation may **amplify** rather than dampen frictions.

Results

1. **Descriptive evidence on credit lines.**
   - Undrawn balances are larger than all used bank-firm credit combined.
   - Overwhelmingly concentrated among largest, most profitable firms.

2. **Empirics: role of credit lines in transmission.**
   - Explain virtually all of firm bank loan response to cash flow changes.
   - Dominate credit response to COVID-19 outbreak & monetary policy shocks.
   - Draws on credit lines crowd out term lending following COVID-19 outbreak.

3. **Structural model: general equilibrium implications.**
   - Credit lines essential to explaining flow of credit toward unconstrained firms in bad times.
   - Flow from high to low marginal propensity to invest firms can worsen capital decline.

Data

- Schedule H.1 of Federal Reserve's Y-14Q data
  - Covers all bank holding companies with >$50 billion in assets ($100 billion post-2019).
  - Sample: 2012:Q3 - 2020:Q3, ∼50 percent of bank C&I loans.
  - We exclude financial and real estate firms.
- Highly detailed data with key features unavailable in typical data sets.
  - Loan-level panel with quarterly updates on universe of loan facilities >$1 million.
  - Identifies credit as term loan or credit line, amount of undrawn credit.
  - Broad sample of firms: 2,342 public, 202,182 private.
  - Income and balance sheet information of borrowers (supplemented by Compustat & Orbis).

Summary Statistics

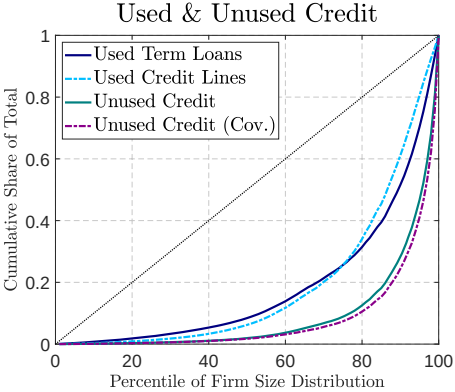
- **Fact #1:** Credit lines account for more than half of used bank credit.
- **Fact #2:** Committed but unused credit >40% larger than *all* used bank credit.

	Total	Credit Lines	Term Loans
Loan Facility Observations	4,496,353	58%	42%
Used Credit	$941B	53%	47%
Committed Credit	$2,231B	78%	22%

Note: Numbers represent quarterly averages over 2012:Q3-2019:Q4.

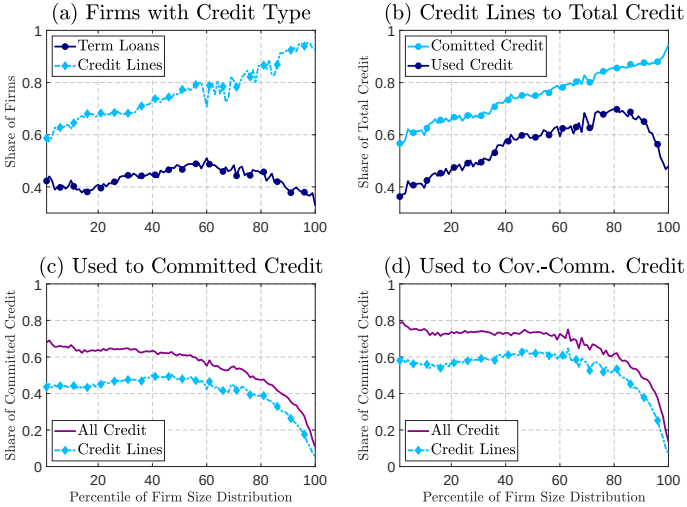
Allocations by Size

- **Fact #3:** Unused credit capacity overwhelmingly held by largest firms.
- Top 10% account for 72% - 75% of unused credit (vs. 39%-48% of used credit).



Credit Characteristics

- Share of firms with credit lines increases with size.
- Larger firms have more committed credit in form of credit line.
- Largest firms keep huge reserves of committed credit.



Which Firms have Credit Lines and Unused Capacity?

- For firm i in industry k at time t we estimate:

$$\frac{UnusedCredit_{i,t}}{CommittedCredit_{i,t}} = \underbrace{\alpha_t + \tau_k}_{\text{fixed effects}} + \beta' X_{i,t-1} + u_{i,t}$$

- **Answer:** larger, more profitable firms with better access to alternative forms of credit.

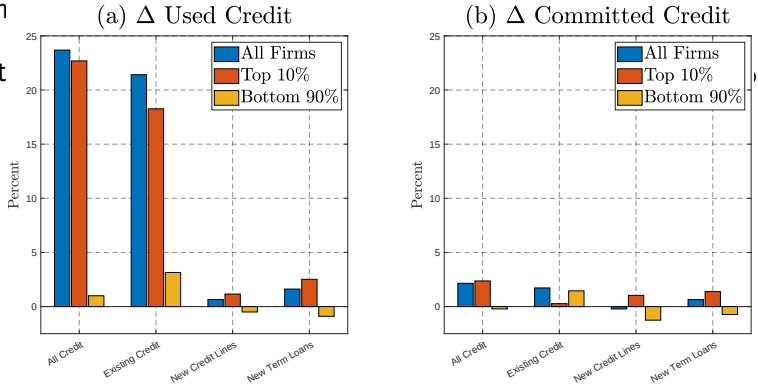
	Size	Age	Public	EBITDA	Leverage	Tangible Assets	Inv. Grade
Coeff.	0.02***	0.02***	0.13***	0.28***	-0.58***	0.18***	0.12***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
R^2	0.27						
N	145,547						
# Firms	29,820						

Sample: 2012:Q3-2019:Q4, standard errors in parentheses are clustered by firm.

Empirics: Role of Credit Lines in Transmission

Credit Movements Around COVID-19 Outbreak

- Decompose credit growth following COVID-19 outbreak by firm and loan type.
- Measure of growth: $\left(L^{k,g}_{2020:Q1} - L^{k,g}_{2019:Q4}\right) / (\text{Total Used Credit}_{2019:Q4})$.
- Growth dom
- Vast majorit , of used credit).



COVID-19: Credit Supply

- Did banks experiencing drawdowns on their credit lines reduce their term lending?
  - Need to isolate credit supply effect from links between bank-firm selection and firm demand.
- We follow Khwaja and Mian (2008) in using firm fixed effects to control for firm demand.
- For firm i, bank j, and loan type k, we run the $t = 2020{:}Q1$ regression:

$$\frac{L_{i,t}^{j,k} - L_{i,t-1}^{j,k}}{0.5 \cdot (L_{i,t}^{j,k} + L_{i,t-1}^{j,k})} = \underbrace{\alpha_i^k}_{\text{FE}} + \beta \underbrace{\frac{\Delta \textit{Existing Credit Lines}_t^j}{\textit{Assets}_{t-1}^j}}_{\text{drawdowns at bank } j} + \gamma' X_t^j + u_i^{j,k}$$

- Identification comes from firms with multiple bank relations.
- We further restrict the sample to firms with term loans only.

COVID-19: Credit Supply

- Drawdowns equal to 1% of bank assets lead to 2.0% - 2.6% decrease in term lending.
- Effects persist and slightly strengthen into 2020:Q2 and 2020:Q3.
- Drawdowns not offset by deposit inflows, points against liquidity as direct mechanism.
- Interpreting magnitudes: $1 of drawdown leads banks to contract lending by 10-30 cents.

	(i) 2020:Q1	(ii) 2020:Q1	(iii) 2020:Q1	(iv) 2020:Q2	(v) 2020:Q3	(vi) 2020:Q1
Δ Credit Line Usage	-1.96***	-2.28***	-2.57***	-3.03***	-3.63***	-1.85***
	(0.72)	(0.65)	(0.91)	(1.14)	(1.62)	(0.63)
Δ Deposits						0.18
						(0.21)
Fixed Effects						
Firm × Rate	✓			✓	✓	✓
Firm × Rate × Maturity		✓				
Firm × Rate × Purpose			✓			
Bank Controls			✓			✓
R-squared	0.51	0.51	0.55	0.51	0.53	0.51
Observations	1,678	1,596	1,007	1,519	1,390	1,678
Number of Firms	749	712	464	682	624	749
Number of Banks	28	28	27	28	28	28

Standard errors in parentheses are clustered at the bank level.

COVID-19: Further Evidence

- **Bank Constraints**
  - Banks with lower pre-crisis capital buffers restricted term lending by more
  - Results robust to IV with unused drawdowns & controls for portfolio losses
- **Heterogeneity in Transmission**
  - SMEs experienced sharper lending cuts
  - Results hold for single bank-firm relations
- **Total Debt and Investment Outcomes**
  - Larger bank drawdowns reduce total debt and investment
  - But only for smaller firms $\implies$ heterogeneous MPIs

Structural Model

Model Overview

- Distributional implications $\implies$ two types of firm.
  - Constrained firms have high exit rate $\implies$ binding minimum on dividend payouts (high MPI).
  - Unconstrained firms have low exit rate $\implies$ interior on dividend payouts (low MPI).
- Tax shield $\implies$ firms prefer debt finance.
- Credit lines (held by unconstrained firms only) $\implies$ debt promised at fixed spread.
  - Constrained firms borrow with term loans at current market spread.
- Realistic debt limits: debt-to-EBITDA covenants following Greenwald (2019).
  - Idiosyncratic cash flow shocks can push firm into violation.
  - At equilibrium, firms keep buffer to reduce violation risk, but not literally constrained.

Model Overview

- Key margins of adjustment following negative shock:
  - ↓ Dividends (CARA investor utility $\implies$ preference for smooth payouts).
  - ↓ Investment (adjustment costs, lower future profits).
  - ↑ Debt (covenant violation risk).
- Continuum of ex ante identical banks owned by saver. Differ ex post by drawdowns.
  - Unconstrained borrow from all banks, constrained from single bank type b.
- Bank b supplies credit subject to convex funding cost, implies loan pricing

$$\underbrace{(1 + r_{b,t})}_{\text{loan rate}} = \underbrace{(1 + s_{b,t})}_{\text{markup}} \underbrace{(1 + r_t)}_{\text{risk-free rate}}, \qquad s_{b,t} \equiv \eta \left(\frac{L^b_{U,t} + L^b_{C,t}}{L^b_U + L^b_C} \right)^{\zeta_L}$$

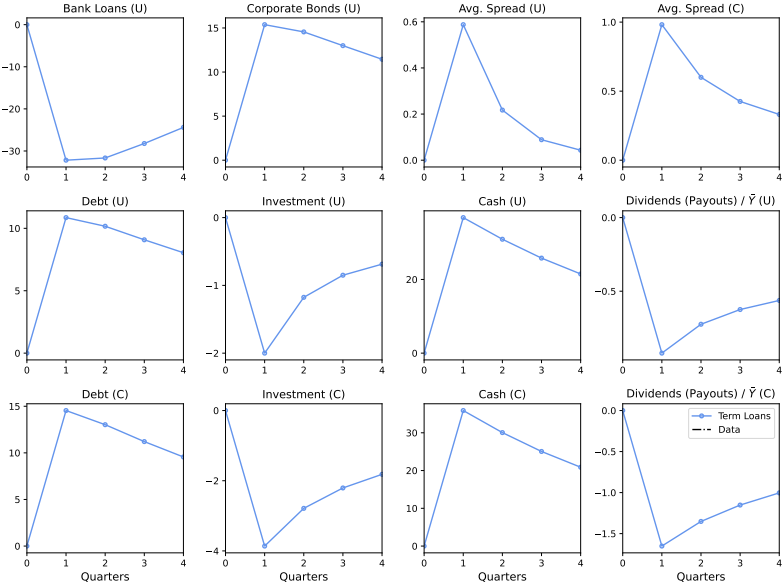
so that spreads increase with credit demand. Calibrate ζ_L to match regression estimates.

COVID-19 Experiment

- Motivated by COVID-19 experience, apply TFP shock generating 10% drop in output.
  - Set persistence ρ_Z to 0.75, matching Survey of Professional Forecasters.
  - Solution method: nonlinear perfect foresight paths back to steady state.
- Consider two economies:
  - **Credit Lines:** baseline economy with credit lines.
  - **Term Loans:** economy with term lending only.

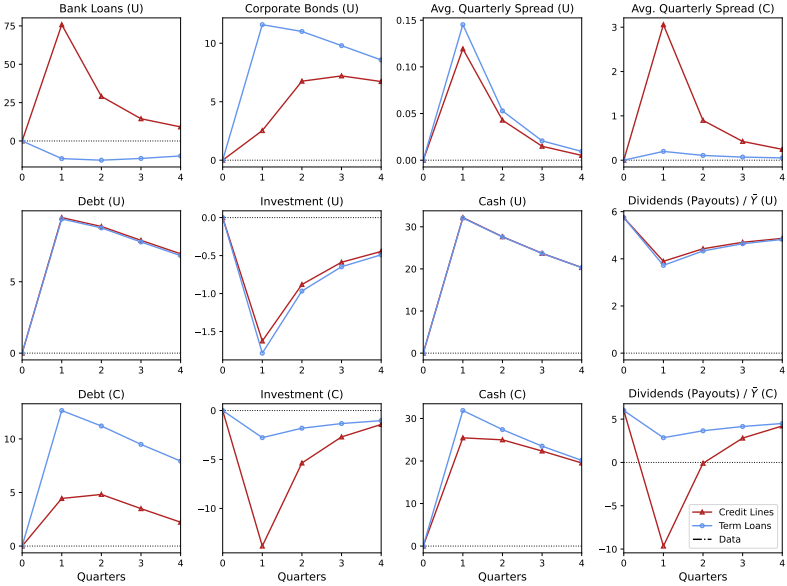
Responses by Type

- **Term Loans** economy.
- Unconstrained firms mostly adjust by cutting dividends.
- Constrained unable to cut dividends, must borrow or disinvest.
- Credit flows from price elastic *U* firms to price inelastic *C* firms (reverse of data).



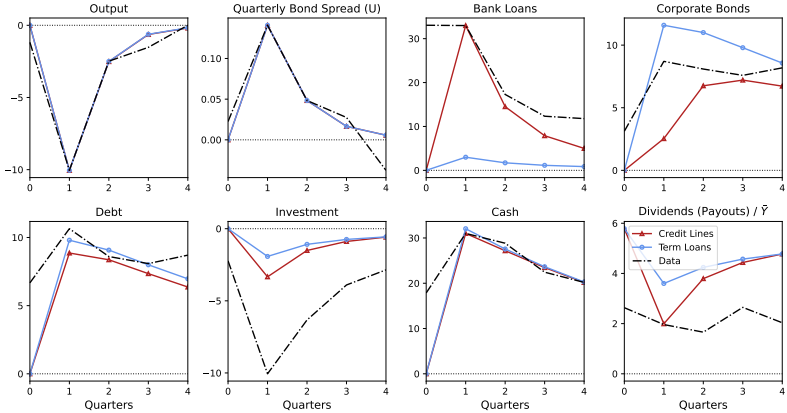
Responses by Type

- **Credit Lines** economy.
- Unconstrained now borrow heavily, mostly use funds to smooth dividends.
- Crowds out credit to constrained (as in data), who instead cut investment by more.



Aggregate Responses

- Compare aggregates in **Credit Lines** vs. **Term Loans** economy.
- Aggregate debt **higher**, as unconstrained borrow more, constrained don't cut enough to offset.
- But aggregate investment **lower**, as resources flow from highest MPI to lowest MPI firms.



Summary: The Credit Line Channel

- Detailed bank-firm registry reveals importance of credit lines for credit flows.
  - Have committed but unused balances 40% larger than all used bank credit combined.
  - Account for virtually all of rise in bank credit to firms following adverse shocks.
- Credit lines are overwhelmingly concentrated among the largest, most profitable firms.
  - Draws on credit lines can crowd out term lending to smaller, more constrained firms.
- Model shows that credit lines are essential to reproducing flow of credit toward unconstrained firms in bad times.
  - Flow from high to low MPI firms can worsen disinvestment even though aggregate credit rises.

Conclusions

- Financial frictions appear key to macro dynamics.
  - Robust links between firm financing, credit spreads, and real activity.
  - May be due to true default risk or shocks originating the financial sector.
  - Drop in financial sector risk capacity seems critical to 2008 crisis.
- Structure of corporate debt limits seems important.
  - Debt limits written on earnings (and often interest!) rather than collateral constraints.
  - Covenant violations combined perversely with lender health in the crisis.
  - Interaction between covenants could lead to state dependent transmission.
- So does structure of lending facilities.
  - Massive undrawn credit line capacity dominated by large, unconstrained firms.
  - Large draws in bad states can crowd out lending to small firms, deepening recession.