Debt Covenants and the Macroeconomy: The Interest Coverage Channel

Daniel L. Greenwald

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Introduction

- Non-residential investment is a key driver of monetary policy response.
  - Natural link: $6T 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.
  - 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.
This Paper

▶ **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: $r_t \downarrow 100 \text{bp} \implies$ 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: $r_t \downarrow 100 \text{bp} \implies$ extra 2.1% 8Q asset growth for firms w/ these covs when $r_{t-1}$ 100bp higher.
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Literature Review


  **Here:** Focus on macro dynamics, interest rate transmission.


  **Here:** Role of covenant structure in strength of transmission.

- **Covenants and Transmission:** Drechsel (2019), Lian Ma (2018).

  **Here:** Effect of interest coverage, state dependence through covenant interactions.
Background: Debt Covenants

- **Covenants:** provide conditions that, if violated by the firm, allow lender to demand accelerated repayment.
  - Often set thresholds for financial ratios \( \Rightarrow \) 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 \( \theta^{IC} \) of earnings (EBITDA).
  2. **Debt/Earnings (DE):** restrict stock of debt \( \leq \) fraction \( \theta^{DE} \) of earnings (EBITDA).
  3. **Leverage:** restrict stock of debt \( \leq \) fraction \( \theta^{LEV} \) 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, capacity for new borrowing even more sensitive.
  - Share of interest cap consumed by existing debt also varies with rates.
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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

- Below: initial covenant ratios at origination in DealScan.
  - Average across loans, weighted by deal amount.

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.

(a) Interest/EBITDA Ratio
(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.

(a) Interest/EBITDA Ratio

(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 \( \Rightarrow \) time varying discount factor (both agents):
    \[
    \log \beta^*_t = (1 - \rho_\beta) \log \bar{\beta} + \rho_\beta \beta_{t-1} + \epsilon_{\beta,t}.
    \]

- **Productive technology**:
  \( f(K_{t-1}, N_t) = Z_t K_{t-1}^\alpha N_t^\gamma \)
  - Diminishing returns \( (\alpha + \gamma < 1) \Rightarrow \) 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 \( \Rightarrow \) dividend smoothing motive (**financing frictions**).
  - Combined: pathway from debt limits \( \rightarrow \) debt \( \rightarrow \) investment.

- **Flexible prices and wages, monetary authority targets achieves inflation target.**
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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 $\Lambda^E_{t+1}$ is the entrepreneur SDF, subject to the budget constraint

$$D_t = (1 - \tau) \left( f(K_{t-1}, N_t) - w_t N_t \right) + \tau \delta K_{t-1} - i_t K_{t-1}$$

- after-tax profit
- depreciation credit
- investment
- interest payment
- net principal

and the borrowing constraint (debt covenants).

Household’s Problem
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**: $\bar{B}^{IC}_t = \frac{\theta^{IC} X_t}{r_t}$.
  2. **Debt/Earnings**: $\bar{B}^{DE}_t = \theta^{DE} X_t$.
  3. **Leverage**: $\bar{B}^{LEV}_t = \theta^{LEV} BV_{t-1} \simeq \theta^{LEV} K_{t-1}$.

- Only Interest Coverage **directly shifted** by interest rates.
  - Highly sensitive, semielasticity of $\bar{B}^{IC}$ to rates $\sim 16$.

- Overall debt limit is smoothed to allow for e.g., annual financial statistics:
  
  $$B_t \leq \rho \bar{B}_t + (1 - \rho) \pi^{-1}_t B_{t-1}$$
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Collateralizability

- Additional channel (beyond financial friction) linking covenants and investment.

- Optimality condition for investment:

  \[
  \Phi'(i_t) = \Omega_t + M_t E_t \left[ \frac{\partial B_{t+1}}{\partial K_t} \right]
  \]

  - Marginal Cost
  - Value of CFs
  - Collateral Benefit

- Key object is **collateralizability** of investment: \( \partial B_{t+1} / \partial K_t \):

  \[
  \frac{\partial B_{t+1}^{IC}}{\partial K_t} = \frac{\theta^{IC} f_{K,t+1}}{r_{t+1}}, \quad \frac{\partial B_{t+1}^{DE}}{\partial K_t} = \theta^{DE} f_{K,t+1}, \quad \frac{\partial B_{t+1}^{LEV}}{\partial K_t} = \theta^{LEV}.
  \]

- 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).
  - Drop finance + real estate, public utilities, public administration, mining, construction.
  - Assume firm has covenant until loan matures or EBITDA becomes 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.

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\[N\] 99,669 36,522 29,132 24,237 24,401 4,137 3,334

Source: Dealscan, Compustat. Additional Groupings
### Firm Characteristics by Covenant

- Firms with IC + DE covs largely similar. Firms with Leverage covenants a bit smaller.

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### Additional Groupings

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The Interest Coverage Channel

NBER SI, July 2019 17 / 33
Differences much more muted in selected (high-asset, high-margin) sample.

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<td>1,582</td>
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Source: Dealscan, Compustat.
Calibration (Quarterly)

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name</th>
<th>Value</th>
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<td>Labor Share</td>
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<td>1% Markup</td>
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<td>Y</td>
<td>Debt/EBITDA = 8.42</td>
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<td>$\theta^{LEV}$</td>
<td>0.227</td>
<td>Y</td>
<td>Debt/EBITDA = 5.42</td>
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</table>
Results
Comparison: Covenant Types

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

- Additional 8Q growth of debt (20.2%), capital (9.4%), EBITDA (9.1%) relative to DE econ.
- IC economy: large relaxation of debt limits $\implies$ capital, EBITDA growth $\implies$ feedback.

![IRF to Discount Rate](image1.png)

- Interest Cov.
- Debt/EBITDA
- Leverage

![IRF to Discount Rate](image2.png)

- Interest Cov.
- Debt/EBITDA
- Leverage

![IRF to Discount Rate](image3.png)

- Interest Cov.
- Debt/EBITDA
- Leverage
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 ↓ 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:

\[ y_{i,t+h} = \alpha_i + \phi_{ind,t} + \sum_{\text{cov}} \mathbb{I}_{\text{cov},t} \cdot (\beta_{0,\text{cov}} + \beta_{1,\text{cov}} \Delta r_t) + \gamma' X_{i,t-1} + \delta' (X_{i,t-1} \cdot \Delta r_t) + \epsilon_{i,t} \]

where \( r_t \) is 3-Month T-Bill, outcome \( y_{i,t+h} \) and controls \( X_{i,t-1} \) are scaled by \( \text{Asset}_{i,t-1} \).

▶ 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 \( \Delta r_t \) and controls
- Directly compare firms with IC and DE covenants.
Empirical Evidence: Covenant Types

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

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

- Are these numbers reasonable? Compare to model prediction.
- Close to model response of assets (9.7%), smaller than prediction for debt (9.6%).

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

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

- Calibrate $\sigma_e$ 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).

Source: DealScan, Compustat, equally weighted.
Measuring Covenant Tightness

- Apply to Dealscan data \(\Rightarrow\) large variation in implied fraction with IC as tightest covenant.
  
  - Range from high of 58.9% in 2007 Q1 to low of 6.8% in 2003 Q2.

Source: DealScan, Compustat, equally weighted.
Measuring Covenant Tightness

- Average share with IC tighter: 32.9%.
  - Calibrate model to match at steady state.

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).

### Additional Variables
The Impact of Interest on Debt, Capital, and EBITDA under High and Low Rates.
State Dependence: DE + IC Covenants

- Stronger transmission when rates are high (73.4% IC binds) vs. low (1.3% IC binds).
- Additional 8Q growth in debt (7.9%), capital (2.1%) in high vs. low rate regime.

Additional Variables
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

$y_{i,t+h} = \alpha_i + \phi_{ind,t} + \sum_{s \in \{0,1\}} \left( I_0 + I_1 r_{t-1} \right) \left\{ \sum_{cov} \left( \beta_{0,cov}^s + \beta_{1,cov}^s \Delta r_t \right) + \gamma'_s X_{t-1} + \delta'_s (X_{t-1} \cdot \Delta r_t) \right\} + \epsilon_{i,t}$

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.

By Regime

Daniel L. Greenwald
The Interest Coverage Channel
NBER SI, July 2019 31 / 33
Empirics: State Dependence

- Focus on interaction between $r_{t-1}$, having both IC + DE covenants, $\Delta r_t$.
- Increased 8Q growth in debt (1.5%), assets (2.1%) for every 1ppt increase in $r_{t-1}$.

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.
Empirics: State Dependence

- Focus on interaction between $r_{t-1}$, having both IC + DE covenants, $\Delta r_t$.

- Increased 8Q growth in debt (1.5%), assets (2.1%) for every 1ppt increase in $r_{t-1}$.

- Point estimates $\sim 3x$ larger than model predictions for debt (0.6%), assets (0.6%).

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.
Empirics: State Dependence

- What could explain stronger response in the data?
  - Spreads could move more than 1-for-1 with interest rate (e.g., “performance pricing”).
  - Interest rate volatility higher when rates are high (e.g., Cox Ingersoll Ross, 1985).

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.
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.
Conclusion

- 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.

- Looking ahead:
  - In progress: aggregating to a macro impact.
  - Fixed rate debt \(\Rightarrow\) weaker but more path dependent transmission.
Empirics: State Dependence

▶ Lower estimated state dependence for IC-Only firms, as predicted.

▶ Some positive effect unsurprising as constraints are tighter when rates high (unlike for DE).

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.
Empirics: State Dependence, High vs. Low Rate Regimes

Augment original regression so coefficients depend on interest rate regime (cutoff = 3.56%):

\[
y_{i,t+h} = \alpha_i + \phi_{ind,t} + \sum_{s \in \{hi, low\}} \mathbb{I}_{s,t} \left\{ \sum_{cov} \mathbb{I}_{cov,t} \cdot \left( \beta_{0,cov}^s + \beta_{1,cov}^s \Delta r_t \right) + \gamma_{s}^t X_{t-1} + \delta_{s}^t (X_{t-1} \cdot \Delta r_t) \right\} + \epsilon_{i,t}
\]
Empirics: State Dependence, High vs. Low Rate Regimes

▶ Larger response when rates are high vs. low.

▶ Again, estimates are substantially larger than predicted.

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.
Empirics: State Dependence, High vs. Low Rate Regimes

- Split sample by whether rates are high or low (cutoff: T-Bill rate = 3.56%).
- Both firms borrow more than DE-Only firms when rates high, similar when rates low.

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.
Empirics: State Dependence, High vs. Low Rate Regimes

- Split sample by whether rates are high or low (cutoff: T-Bill rate = 3.56%).
- Reverse pattern for Both vs. IC-Only, matching theory.

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.
Measuring Covenant Tightness: Details

- What is the probability that a firm violates its covenant over the next 4Q?

- Firm with DE covenant violates if 4Q EBITDA growth sufficiently low:

  \[ \Delta_4 X_{t+4}^{4Q} < \log B_t - \log \theta^{DE} - \log X_t^{4Q} \]

- Firm with IC covenant violates if 4Q growth in EBITDA/r sufficiently low:

  \[ \Delta_4 \left( \log X_{t+4}^{4Q} - \log r_{t+4}^{4Q} \right) < \log B_t - \log \theta^{IC} - \log X_t^{4Q} + \log r_t^{4Q} \]

- Assume that these growth rates are Gaussian. Tighter = more likely to violate.

- Take robust estimate of dispersion (matching IQR) to deal with extreme values. Estimated distributions show additional risk from IC covenants:

  \[ \sigma_X = 0.189 \quad \sigma_{rX} = 0.291. \]
What Determines Covenant Tightness?

- Previous conjecture explains why firm might have both covenants, but not dispersion in relative tightness.

- Below: $\theta^{IC}$ and $\theta^{DE}$ ratios on existing loans, by log assets (normalized by quarter median).

![Graph of IC Threshold vs Log Assets (Normalized)]

![Graph of DE Threshold vs Log Assets (Normalized)]
What Determines Covenant Tightness?

- Larger firms tend to have looser DE thresholds, but **tighter** IC thresholds.
  - Explained by higher spreads on smaller firms?
What Determines Covenant Tightness?

- Sorting by credit rating even more confusing (both looser for lower rating).
  - Related to selection into covenants for investment-grade firms in the first place?
What Determines Covenant Tightness?

- Comparing limits: IC relatively tighter for large firms (effect of rating less clear).
  - Does this matter for transmission?

![Graph showing the relationship between Log(IC/DE) and Log Assets (Normalized).]

![Graph showing the relationship between Log(IC/DE) and Credit Rating (Lower = Safer).]
Empirics: State Dependence

- Alternative measure of state dependence: diff-in-diff of Both relative to DE-Only
- Noisier, but still shows excess state dependence for Both firms.

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.
Monetary Policy Shocks

- Replace $\Delta r_t$ with identified MP shocks following Gertler and Karadi (2012)

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.
Representative Household’s Problem

- Rep. household chooses consumption $C_t$, labor supply $N_t$ and new debt $B_t$ to maximize

$$V^S(B_{t-1}) = u(C_t) - v(N_t) + \beta E_t[V^S(B_t)]$$

subject to the budget constraint

$$C_t = (1 - \tau)w_tN_t + r_t\pi_t^{-1}B_{t-1} - (B^*_t - \pi_t^{-1}B_{t-1}) + T^S_t$$

 labor income  interest payment  net debt issuance  transfer
Firm Characteristics by Covenant: Additional Groupings

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<tr>
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<th>None</th>
<th>Any</th>
<th>Non-IC</th>
<th>IC + Lev</th>
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<th>Lev Only</th>
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<td>Sales</td>
<td>10.45</td>
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Source: Dealscan, Compustat.
## Firm Characteristics by Covenant: Selected Sample

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Source: Dealscan, Compustat.