Asset Collateralizability and the Cross-Section of Expected Returns

Hengjie Ai\textsuperscript{1}  Jun Li\textsuperscript{2}  Kai Li\textsuperscript{3}  Christian Schlag\textsuperscript{2}

\textsuperscript{1}University of Minnesota  
\textsuperscript{2}Goethe University Frankfurt  
\textsuperscript{3}Hong Kong University of Science and Technology

May 23, 2017
Introduction

- **Background:** A large literature of macroeconomic models of financial frictions
  - **Theory:** Agency costs force firms to use collateral to borrow capital
  - **Implications:** Financial accelerator effect, affect aggregate asset market

This paper: are there cross-sectional implications?

**Theory:** Countercyclical tightness of the collateral constraint

**Prediction:** Collateralizable asset hedges for aggregate shocks

**Overview of the paper:**
- **Theory:** a canonical GE model of collateral constraint
- Quantify the asset pricing implications in the cross-section
- Supporting evidence: high collateralizability ⇒ lower return
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- **Theory:** a canonical GE model of collateral constraint
- **Quantify the asset pricing implications in the cross-section**
- **Supporting evidence:** high collateralizability ⇒ lower return
Related Literature

- Macroeconomic effects of financial frictions
  - This paper: Quantitative asset pricing implications

- The effect of financial frictions on aggregate stock market
  - He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014), Li (2017)
  - This paper: Focus on the cross section

- Literature on whether financial constraints risk is priced: weak evidence
  - Lamount et. al. (2001), Gomes et. al. (2004), Whited and Wu (2006)
  - This paper: Business cycle fluctuations of collateral constraint
  - Asset collateralizability channel, interact with financial constraint
Overview

- A canonical GE model of financial frictions
- This paper: Quantify the asset pricing implications in the cross section.
Overview

- A canonical GE model of financial frictions
- **This paper**: Quantify the asset pricing implications in the cross section.
- Household: Two members, worker and entrepreneur
  - Worker
    - Consume, work and save
    - Can only save through a risk-free account with entrepreneur
  - Entrepreneur
    - Borrow from worker, and acquire capital and run a neoclassical firm
    - Face a collateral constraint (micro-funded by limited enforcement)
- Neoclassical non-financial firm
Worker and Non-financial Firm

- Worker’s consumption and saving problem:

\[
\max_{C_t, B_t, L_t} U_t = \left\{ (1 - \beta)C_t^{1-\frac{1}{\psi}} + \beta(E_t[U_{t+1}^{1-\gamma}])^{1-\frac{1}{\psi}} \right\}^{\frac{1}{1-\frac{1}{\psi}}}
\]

s.t. \( C_t + B_t = R_{t-1}B_{t-1} + W_tL_t + \Pi_t \)
Worker and Non-financial Firm

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\]

s.t. \( C_t + B_t = R_{t-1} B_{t-1} + W_t L_t + \Pi_t \)

- Non-financial firm

  - Cobb-Douglas production function:

\[
Y_t = A_t (K_t^\phi H_t^{1-\phi})^\alpha L_t^{1-\alpha}
\]

- \( K_t \) is collateralizable asset, \( H_t \) is non-collateralizable asset

- \( A_t \) is the exogenous aggregate productivity.
Entrepreneurs

- The entrepreneurs come in overlapping generations.
- Each period $t$, a $(1-\lambda)$ fraction of entrepreneurs forced to liquidate, and their net worth paid off to household as dividend.
- The measure of new entrepreneurs will come at time $t$, with initial wealth provided by household.
- Standard assumption for agency frictions in persist in the long run.
Entrepreneurs

- Optimization problem of a typical generation-0 entrepreneur:

\[ V_0 = \max \left\{ N_{t+1}, K_{t+1}, H_{t+1}, B_t \right\}_{t=0}^\infty E_0 \left[ \sum_{t=1}^\infty M_{0,t} \lambda^{t-1} (1 - \lambda) N_t \right] \]
Entrepreneurs

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\[ N_t + B_t = q_t K_{t+1} + p_t H_{t+1}, \quad t \geq 0 \]
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\[ N_t + B_t = q_t K_{t+1} + p_t H_{t+1}, \quad t \geq 0 \]

\[ N_{t+1} = R^K_{t+1} q_t K_{t+1} + R^H_{t+1} p_t H_{t+1} - R^f_t B_t, \quad t \geq 0 \]
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The stochastic discount factor is MRS from worker’s problem.
Asset Markets

- **Assets:**
  - $R^K_{t+1}$: Return on collateralizable asset
  - $R^H_{t+1}$: Return on non-collateralizable asset
  - $R^f_t$: Risk-free rate for household loan
  - $R^I_t$: (Shadow) interest rate among entrepreneurs
**Asset Markets**

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  - $R_I^t$: (Shadow) interest rate among entrepreneurs

- Recursive form of entrepreneurs' problem

$$V(N_t) = \max_{K_{t+1}, H_{t+1}, B_t, B_I^t, N_{t+1}} E_t M_{t+1} [\lambda V(N_{t+1}) + (1 - \lambda) N_{t+1}]$$

s.t. $N_t = q_t K_{t+1} + p_t H_{t+1} - B_t - B_I^t$

$N_{t+1} = R^K_{t+1} q_t K_{t+1} + R^H_{t+1} p_t H_{t+1} - R_f^t B_t - R_I^t B_I^t$

$B_t \leq \zeta q_t K_{t+1}$
Augmented SDF

- Entrepreneur’s value function: conjecture and verify $V(N_t) = \mu_t N_t$
  - $\mu_t$: marginal value of net worth
Augmented SDF

- Entrepreneur’s value function: conjecture and verify $V(N_t) = \mu_t N_t$
  - $\mu_t$: marginal value of net worth
- Augmented SDF for entrepreneurs:
  $$\tilde{M}_{t+1} = M_{t+1} \frac{\lambda \mu_{t+1} + (1 - \lambda)}{\mu_t}$$
  - $\lambda \mu_{t+1} + (1 - \lambda)$: weighted average of marginal value of net worth
  - The augmented SDF prices $R^K_{t+1}$, $R^H_{t+1}$ and $R^I_t$
  - The worker’s SDF prices $R^f_t$
Interest Rates

- Equilibrium conditions for $R^f$ and $R^I$:

\[
1 = E_t \left[ \tilde{M}_{t+1} \right] R^f_t + \eta_t \\
1 = E_t \left[ \tilde{M}_{t+1} \right] R^I_t 
\]

- $\eta_t$ Lagrangian multiplier of the collateral constraint
Interest Rates

- Equilibrium conditions for $R^f$ and $R^l$:

\[
1 = E_t \left[ \tilde{M}_{t+1} \right] R^f_t + \eta_t \\
1 = E_t \left[ \tilde{M}_{t+1} \right] R^l_t
\]

- $\eta_t$ Lagrangian multiplier of the collateral constraint

- The interest rate spread

\[
R^l_t - R^f_t = \eta_t R^l_t
\]

- Limits to arbitrage: $R^l_t - R^f_t > 0$ when constraint is binding, $\eta_t > 0$

- The spread disciplines the calibrated tightness of financial constraints
Capital Returns

- Equilibrium conditions for $R^K$ and $R^H$:

  \[
  1 = E_t \left[ \tilde{M}_{t+1} R^H_{t+1} \right] \\
  1 = E_t \left[ \tilde{M}_{t+1} R^K_{t+1} \right] + \zeta \eta_t
  \]

- Return on non-collateralizable asset

  \[
  R^H_{t+1} = \frac{Y^H_{t+1}}{p_t} = \frac{\text{MPK}^H_{t+1} + p_{t+1}(1 - \delta^H)}{p_t}
  \]

- Return on collateralizable asset

  \[
  R^K_{t+1} = \frac{Y^K_{t+1}}{q_t} = \frac{\text{MPK}^K_{t+1} + q_{t+1}(1 - \delta^K)}{q_t}
  \]
Capital Returns

- **Valuation for non-collateralizable asset:**

\[ p_t = \frac{E_t(Y_{t+1}^H)}{R_t^l} + \text{Cov}_t \left[ \tilde{M}_{t+1}, Y_{t+1}^H \right] \]

- **Valuation for collateralizable asset:**

\[ q_t = \frac{E_t(Y_{t+1}^K)}{R_t^l} + \text{Cov}_t \left[ \tilde{M}_{t+1}, Y_{t+1}^K \right] + \frac{\zeta \eta_t}{1 - \zeta \eta_t} E_t \left[ \tilde{M}_{t+1} Y_{t+1}^K \right] \]

- **Hedging:** countercyclical \( \eta_t \) ⇒ countercyclical marginal value of relaxing the constraint
Decomposition of Expected Return Spread

- Expected return spread
  \[ E_t[\tilde{M}_{t+1}(R^H_{t+1} - R^K_{t+1})] = \zeta \eta_t \]

- Decomposition
  \[ E_t[R^H_{t+1} - R^K_{t+1}] = \frac{\zeta (R^I_t - R^f_t)}{E_t[\tilde{M}_{t+1}]} - R^I_t \text{Cov}_t(\tilde{M}_{t+1}, R^H_{t+1} - R^K_{t+1}) \]
  - liquidity premium
  - risk premium

- Testable implication: TED predicts expected return spread.
Impulse Responses of Negative TFP shock

Figure: Impulse Responses of Negative TFP shock
Empirical Targets

- Measure Firm Collateralizability
- Sort portfolio on collateralizability
  - Finding: Firms with high proportion of collateralizable assets earn lower return.
- Interact portfolio sorting with financial constraint measure
  - Finding: The effect more pronounced among constrained firms.
- Conditional AP test
  - Finding: The effect more pronounced under tight aggregate liquidity condition.
Collateralizability Measure

Figure: Collateralizability Measurement Framework
Collateralizability Measure

- The collateral constraint:

\[ B \leq \zeta_S S + \zeta_E E \]
Collateralizability Measure

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  \[ B \leq \zeta_S S + \zeta_E E \]

- Empirical implementation: Focus on a subset of financing constrained firms:
  \[ \frac{B_{i,t}}{AT_{i,t}} = \zeta_S \theta_{i,t}^S + \zeta_E \theta_{i,t}^E. \]
Collateralizability Measure

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- \( \theta_{i,t}^S \) and \( \theta_{i,t}^E \): the share of structure and equipment in book asset, \( AT_{i,t} \).

\[
\theta_{i,t}^S = \frac{S_{j,t}}{FA_{j,t}} \times \frac{PPENT_{i,t}}{AT_{i,t}},
\]
\[
\theta_{i,t}^E = \frac{E_{j,t}}{FA_{j,t}} \times \frac{PPENT_{i,t}}{AT_{i,t}},
\]

- \( \frac{S_{j,t}}{FA_{j,t}} \) and \( \frac{E_{j,t}}{FA_{j,t}} \): industry specific ratio of structure and equipment w.r.t. total fixed asset, from BEA fixed asset table.
Collateralizability Measure

- Book leverage regression:

\[
\frac{B_{i,t}}{AT_{i,t}} = const + \zeta_S \theta_{i,t}^S + \zeta_E \theta_{i,t}^E + \gamma X_{it} + \sum_j \text{Industry}_j + \sum_t \text{Year} + \varepsilon_{i,t},
\]

where \( X_{it} \) are controls including profitability, \( Q \), earnings volatility, marginal tax rate and the rating dummy.
Collateralizability Measure

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\]

where \(X_{it}\) are controls including profitability, Q, earnings volatility, marginal tax rate and the rating dummy.

- The collateralizability measure:

\[
\left(\hat{\zeta}_S \theta_{i,t}^S + \hat{\zeta}_E \theta_{i,t}^E\right) \frac{AT_{i,t}}{PPENT_{i,t} + \ln \tan_{i,t}}.
\]

- It measures the proportion of firms collateralizable assets with respect to the firm’s total physical plus intangible asset.

- Intangible capital measure: Peters and Taylor (2016)
## Capital Structure Regression

<table>
<thead>
<tr>
<th></th>
<th>Whole sample</th>
<th>Dividend</th>
<th>SA index</th>
<th>WW Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>uncons.</td>
<td>cons.</td>
<td>uncons.</td>
<td>cons.</td>
</tr>
<tr>
<td>$\zeta_S$</td>
<td>0.110***</td>
<td>0.142***</td>
<td>0.0952***</td>
<td>0.0799***</td>
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<tr>
<td></td>
<td>(15.29)</td>
<td>(11.47)</td>
<td>(11.15)</td>
<td>(5.83)</td>
</tr>
<tr>
<td>$\zeta_E$</td>
<td>0.0330***</td>
<td>0.0672***</td>
<td>0.00959</td>
<td>0.0399***</td>
</tr>
<tr>
<td></td>
<td>(5.41)</td>
<td>(6.19)</td>
<td>(1.34)</td>
<td>(3.39)</td>
</tr>
</tbody>
</table>

|                |            |          |          |          |          |          |
|                | Obs        | 73614    | 34753    | 38779    | 42934    | 29735    | 37994    | 35157    |
|                | r2         | 0.277    | 35157    | 0.285    | 0.288    | 0.280    | 0.304    | 0.289    |

$t$ statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
### Univariate Portfolio Sorting

#### Table: Univariate Portfolio Sorting on Asset Collateralizability, Equal Weighted

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Financially constrained firms, SA index</td>
<td></td>
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<tr>
<td>$R^e(%)$</td>
<td>1.60</td>
<td>1.33</td>
<td>1.21</td>
<td>1.03</td>
<td>0.89</td>
<td>0.71</td>
</tr>
<tr>
<td>$(t)$</td>
<td>4.26</td>
<td>4.35</td>
<td>4.25</td>
<td>3.80</td>
<td>3.19</td>
<td>3.04</td>
</tr>
<tr>
<td>$\sigma(%)$</td>
<td>8.17</td>
<td>6.66</td>
<td>6.18</td>
<td>5.90</td>
<td>6.09</td>
<td>5.05</td>
</tr>
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<td>Financially unconstrained firms, SA index</td>
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</tr>
<tr>
<td>$R^e(%)$</td>
<td>1.14</td>
<td>1.00</td>
<td>0.94</td>
<td>0.85</td>
<td>0.77</td>
<td>0.37</td>
</tr>
<tr>
<td>$(t)$</td>
<td>4.55</td>
<td>3.99</td>
<td>3.64</td>
<td>3.36</td>
<td>2.94</td>
<td>2.87</td>
</tr>
<tr>
<td>$\sigma(%)$</td>
<td>5.47</td>
<td>5.48</td>
<td>5.61</td>
<td>5.47</td>
<td>5.69</td>
<td>2.84</td>
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<td>0.81</td>
<td>0.67</td>
</tr>
<tr>
<td>$(t)$</td>
<td>4.42</td>
<td>4.41</td>
<td>3.98</td>
<td>3.67</td>
<td>3.00</td>
<td>3.72</td>
</tr>
<tr>
<td>$\sigma(%)$</td>
<td>7.32</td>
<td>5.98</td>
<td>5.63</td>
<td>5.67</td>
<td>5.92</td>
<td>3.93</td>
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Table: Asset Pricing Tests (sort on collateralizability)

Panel A: Carhart Four-Factor Model

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Panel B: Fama-French Five-Factor Model

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Testable Implications

Conditional Moments

- TED spread: LIBOR minus Tbill, aggregate funding liquidity measure
- Predictive regression: TED predicts 1-month ahead excess return spread.

### Table: Predictive Regression by TED

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<th>Dividend</th>
<th>WW Index</th>
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<td>(0.051)</td>
<td>(0.074)</td>
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<td>(0.305)</td>
<td>(0.436)</td>
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Summary

- **This paper**: cross-sectional implications of collateral constraint
  - Theory: Countercyclical tightness of the collateral constraint
  - Prediction: Collateralizable asset hedges for aggregate shocks

- **Overview of the paper**:
  - Theory: a canonical GE model of collateral constraint
  - Quantify the asset pricing implications in the cross-section
  - Compelling evidence: high collateralizability $\Rightarrow$ lower return
## Appendix: Firm Characteristics

### Table: Firm Characteristics on Collateralizability Sorted Portfolios

<table>
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<tr>
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