Monetary Surprises, Debt Structure and Credit Misallocation

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1 Abstract

How does firm dynamically adjust its capital and debt structure in response to interest rate risk? I document a new fact that, at the aggregate level, a tightening monetary policy is associated with a rise in bank debt and a decline in market debt, which is not driven by cyclicity. Using micro-data, I find that financially unconstrained firms substitute loans for corporate bonds while financially constrained firms have a higher probability of issuing new equity. I develop a dynamic, heterogeneous firm model to quantitatively explain these patterns. Loan (bond) is modeled as risk-free (defaultable) debt. Firms trade-off long-run interest rates of loan against default risk of bond for the optimal debt structure. An unanticipated interest rate hike raises default risk (cost of debt), defaults with default risk and unbinding collateral constraint substitute loan for bond and therefore credit is reallocated from constrained firms to unconstrained firms. This generates credit misallocation and it raises the dispersion of marginal product of capital. The economic mechanism emphasizes that the firm’s preserved debt financing flexibility is an important determinant of firms’ adjustment in response to interest rate risk. The model solutions quantitatively match the data.

Measurement of Monetary Surprises

1. Measured as the surprise component of changes in the current month’s federal funds futures rate in narrow windows around FOMC announcement.

\[ \epsilon^s = \epsilon_t \times (f_{t+1} - f_t) \]

2. High-frequency, event-study approach (Gurkaynak, Sack and Swanson (2005) and Gorodnichenko and Weber (2016))

3. Cost of capital change (current rate) matters more than the information channel (future rate) by controlling for Greenbook forecast revisions

2 Empirical Evidence

• Sample period: 1990Q1-2008Q4; Data source: Flow of Fund, St Louis Fed, Compastat, FSD, DealScan
• Main results: following an unexpected policy rate hike
  – Aggregate loan share increases while aggregate bond share decreases
  – Financially unconstrained firms tend to borrow more from bank; Financially constrained firms tend to issue more equity
  – Future expected stock return and cash holding go up

Aggregate result: Jorda (2005)-style local projection

Figure 1: Dynamic Effects of Monetary Shocks

Firm-level results

Regression specification:

\[ y_{i,t} = x_i, i \in \{\alpha, \beta, \gamma, \delta, \epsilon, \zeta\} \in \{1, 2, 3\} \]

where \( y_{i,t} \) are the firm-level controls and \( x_{i,t} \) are the macro controls including forecast revisions.

Table 1: Debt Financing Decisions

<table>
<thead>
<tr>
<th>Firm Type</th>
<th>Micro Controls</th>
<th>Macro Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan share</td>
<td>Mismatch</td>
<td>Mismatch</td>
</tr>
<tr>
<td>All firms</td>
<td>0.101</td>
<td>0.850</td>
</tr>
<tr>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

3 Model

Model Assumptions

Assumption 1. ( Liquidity and bankruptcy cost)
Assumption 2. (Seniority of bank lenders)
Assumption 3. (Loan issuance is more costly)
Assumption 4. (Secured loan and defaultable bond)

Environment

• Technology: DRS: \[ y = z^n \theta \] where \( n + \nu < 1 \)
• Productivity: \[ \log(y) = \log(\bar{y}) + \epsilon \]
• Investment: Convex adjustment cost: \[ AC(h', k) = \frac{1}{2} \left( \frac{h - h_0}{k} \right)^2 k \]
• Financial Frictions: \[ \text{F (total debt; x; bond share)} \]
  – Linear debt issuance cost \[ DC(B', y') = \gamma(B'(1-y') + \xi(B' - \gamma(B)) \]
  – Proportional equity issuance cost \[ EC(y') = \beta y'(d < 0) \]
  – Liquidation loss \[ (1-\chi)|1-k| \]
  – Collateralized bank debt \[ B(1+c)B'(1-y') \leq (1-\theta)B' \]
• Fixed target inflation rate: \( \pi \)

Timing

Enter each period with state variables \( z, k, B \), i.e. productivity, capital and total debt
1. Default decision
   • If default, value = 0 and permanently exits. Lender recovers \( \chi(1-\delta)k \).
   • If continue, repay bank and market debt \( b \) and \( m \), and an operating cost \( c_f \).
2. Production \( y = z^n \theta \)
   • Define cash in hand \( u = (1-\tau)z^n \theta - n(1+\delta)|k-\epsilon|+\nu (f(k+B)-B(1+c)|B/B| \)
3. Investment \( \delta \)
   • Internal finance: cash in hand; Costly external debt finance; Costly external equity finance

Firm’s Problem

\[ V(z, k, B) = \max_{d, \delta} \left[ \mathbb{E}[V(z', k', B') \mid d] + \delta \mathbb{E}[\max_{d, \delta} \mathbb{E}[V(z'', k'', B'') \mid d]] \right] \]

\[ \Delta z = (1-\chi)(k''-\epsilon) - (1-\delta)(k' - \epsilon) + \nu (f(k''+B'') - B(1+c)|B/B|) \]

\[ Q(z', k', B', y') = \mathbb{E}[\max_{d, \delta} \mathbb{E}[V(z'', k'', B'') \mid d]] \]

Bond price \( Q(z', k', B', y') \) is pinned down by risk neutral financial intermediary break even condition.

Optimal Debt Structure

Within each period, given states \( z, k, B \), firms choose their optimal debt composition \( s_{i,t+1} \) by solving a static maximization problem. The objective function is

\[ \max_{\delta} (B_{i,t+1} - s_{i,t+1}) + Q_i \text{ if } s_{i,t+1} \leq \min \{ s_{i,t+1} \text{ if } B_{i,t+1} \}

The lower bound of \( s_{i,t+1} \) comes from the collateral constraint. The first-order condition with respect to the optimal bond share \( s_{i,t+1} \) is

\[ \frac{\partial Q_i}{\partial s_{i,t+1}} = 0 \]

No default risk

For \( (z, k, B, z', B') \) such that \( Q_i \leq \frac{1}{\gamma} \), \( s_{i,t+1} = 1 \), i.e., for those firms that do not default, they choose bond only.

With default risk

For \( (z, k, B, z', B') \) such that \( Q_i \leq \frac{1}{\gamma} \),

\[ s_{i,t+1} = 1 \text{ if } \frac{B_{i,t+1} - s_{i,t+1}}{Q_i} \leq \frac{1}{\gamma} \text{ and } \frac{s_{i,t+1}}{B_{i,t+1}} \leq \frac{1}{\gamma} \]

where \( \beta = \frac{1}{\gamma} \) for financially unconstrained firms (collateral constraint does not bind) and \( s_{i,t+1} = 1 \) for financially constrained firms.
4 Model Solution

Figure 4 shows optimal equity value, investment rate, debt issuance and bond price of the firms with average productivity under high rate and low rate. Figure 5 shows more details about debt financing for firms with average productivity but with different level of leverage. In terms of total debt issuance, firms with lower leverage first increase their debt issuance when their capital stock is lower while they gradually reduce debt issuance when their capital stock is high enough. This is because debt is more valuable for low leverage firms due to lower default risk. Firms’ debt payment is relatively low when firms have a large amount of capital stock to generate enough internal funds to finance their future investment. As a result, they do not need a large amount of new debt issuance. Low leverage firms rely on a little amount of loan issuance when they have a lower level of capital stock (higher default risk) but zero when they have enough capital stock. Loan issuance is higher in bad state when interest rate is high due to the substitution effect between loan and bond. In panel (b), debt issuance is increasing in capital stock for firms with high leverage. A large amount of debt payment will significantly reduce the internal funds available generated from production activities regardless of the amount of capital stock they have and therefore, firms have to rely heavily on debt financing given the shortage of internal financing and costly external equity financing.

5 Model Implication

5.1 Cross-sectional Determination of Debt Structure

• By credit rating: This model implies that firms with very high default risk take bank debt only, firms with medium default risk take both bank and market debt simultaneously and firms with very low or no default risk only issue bond debt.

• By size and age: This model also implies that, in the cross section, large firms are bond-financed firms with median default risk take both bank and market debt simultaneously and firms with very low or no default risk only issue bond debt.

5.2 Dynamic Capital, Debt Structure and Interest Risk

Table 3: Capital, Debt Structure and Interest Rate Risk

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: All firms</td>
<td>Loan Ratio,i,t</td>
<td>ΔLoan Ratio,i,t</td>
<td>Leverage,i,t</td>
<td>Loan Ratio,i,t</td>
</tr>
<tr>
<td>Shock</td>
<td>-0.010**</td>
<td>0.003***</td>
<td>-0.001</td>
<td>0.002**</td>
</tr>
<tr>
<td>(1.81)</td>
<td>(9.02)</td>
<td>(-3.64)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>198956</td>
<td>38159</td>
<td>198956</td>
<td>198956</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.396</td>
<td>0.042</td>
<td>0.875</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Constrained</th>
<th>Unconstrained</th>
<th>Constrained</th>
<th>Unconstrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLoan Ratio,i,t</td>
<td>-2.90</td>
<td>3.98</td>
<td>7.82</td>
<td>5.47</td>
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<tr>
<td>Obs</td>
<td>31000</td>
<td>167825</td>
<td>29534</td>
<td>8024</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.567</td>
<td>0.119</td>
<td>0.111</td>
<td>0.113</td>
</tr>
</tbody>
</table>

5.3 Credit and Capital Reallocation

The analysis above implies that bank credit flows from constrained firms to unconstrained firms with preserve debt financing flexibility following a tightening monetary policy. Below I show the ratio of total loan of unconstrained firms to total loan of constrained firms in different economies using the simulated data. The ratio is 0.18 in the high interest rate environment, which is higher than 0.17 in the low interest rate environment. Given that constrained firms are mostly more productive firms, credit misallocation is more severe in bad times. The shortage of external financing raises the dispersion of marginal product of capital (MPK), as shown in the histogram below. The dispersion of marginal product of capital on average is larger under high rate.

Table 4: Credit allocation

<table>
<thead>
<tr>
<th>Loan Ratio</th>
<th>High × Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.181</td>
</tr>
<tr>
<td>Std</td>
<td>0.029</td>
</tr>
</tbody>
</table>

5.4 Real Effects

In this section, I discuss this debt structure channel and model implications on investment, borrowing and firm value. I do the following regression analysis:

\[
\frac{y_{i,t}}{\frac{y_{i,t}}{y_{i,t}}} = \alpha_i + \beta_1 \cdot \text{Loan Ratio}_{i,t-1} + \beta_2 \cdot \text{Leverage}_{i,t-1} + \epsilon_{t-1}
\]

Table 5: Real Effect of the Debt Structure Channel

Conclusions

• I show that firms substitute loans for corporate bonds as a response to an unanticipated interest rate hike on both intensive and extensive margin, especially among financially unconstrained firms. On average, a positive monetary shock is associated with an increase in firms’ risk and future excess return.

• I develop a dynamic, heterogeneous firm model to explain how firms optimally choose their capital and debt structure in the face of investment opportunities and changes in interest rate.

• In this model, firms trade-off between tax benefit and the overall cost of debt financing, which determines the optimal capital structure. Within debt financing, firms trade-off between higher intermediation cost for loans and default risk for bonds for optimal debt structure.

• The model also has interesting implications on cross-sectional debt structure and credit misallocation. It also points out a debt structure channel of monetary policy.

• Overall, the main findings in this paper can be potentially helpful to policymakers in terms of the policy effects on credit reallocation and financial stability.