Capital Structure with Endogenous Liquidation Values

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Liquidation values are an important determinant of distress costs and thus optimal capital structure.

- Example: Firms with more redeployable (less specific) assets have low distress costs and thus have high debt capacity (Williamson, 1988)

Most traditional models of optimal capital structure take asset liquidation values as exogenous (e.g., Harris and Raviv, 1990; Leland, 1994)

But, liquidation values are themselves determined by capital structure choices in the industry.
Higher debt may impact a firm’s incentives to liquidate, especially if creditor rights are strong (e.g., Acharya, Sundaram, and John, 2011; Davydenko and Franks, 2008).

Industry effect: Cash flow shocks are correlated (industry shocks) causing large swings in the supply of liquidated assets in high-debt industries.
Higher debt may reduce demand for liquidated assets because of debt overhang (Myers, 1977)

- financially constrained airlines are less likely to increase their buying activity when aircraft prices are depressed (Pulvino, 1998)

Industry effect: The natural buyers of distressed assets are often firms in the industry that are also distressed (Shleifer and Vishny, 1992)

- Fire sales are more severe when the industry faces an adverse shock (Acharya, et al., 2007)
Direct and indirect effects (via prices) on optimal debt choice

- **Direct effect:** e.g., strong debtor rights $\Rightarrow$ high distress costs (because of continuation bias) $\Rightarrow$ lower debt

- **Indirect effect through prices:** e.g., strong debtor rights $\Rightarrow$ lower supply of liquidated assets $\Rightarrow$ higher liquidation values $\Rightarrow$ fewer future investment opportunities $\Rightarrow$ less incentive to keep debt low

Indirect effect often tempers, and sometimes reverses, effects of parameters on optimal capital structure
risk-neutral, competitive firms

firm type (productivity) is unknown but distributed $U[0, \gamma]$

each firm buys one unit of a productive asset

firms choose debt financing, $D$

receive immediate benefit $\tau \cdot D$ (e.g., tax or other benefit)
Basic Model Setup: Time 1

- Firm management learns type, \( V_i \)
- \( V_i < D \): default
  - Liquidation value, \( P \), is taken as given (but is determined in equilibrium)
  - Continuation results in dissipative costs \( \phi \cdot (D - V_i) \)
  - Assume continuation is efficient: \( V_i \geq \Lambda_{\text{eff}} = \frac{P + \phi \cdot D}{1 + \phi} \)
- \( V_i \geq D \): firm continues unimpeded and may acquire liquidated assets
  - Liquidated assets have value \( \eta \cdot V_i \) to the acquiring firm (\( \eta \) is large when assets are more easily redeployable)
  - Firms can only acquire \( \ell(D) \) units of the asset - functional form is chosen to yield closed-form solutions
  - \( \ell'(D) < 0 \) because of debt overhang
Figure: Model Timing

Time 0
Choose Debt $D$

Time 1
Learn Type $V_i \sim U[0, \gamma]$

- No Default
  $V_i \in [D, \gamma]$

- Default
  $V_i \in [0, D]$

- Liquidate
  $V_i \in [0, \Lambda]$

- Continue
  $V_i \in [\Lambda, D]$

- Operate
  $V_i \in [D, P/\eta]$

- Acquire
  $V_i \in [P/\eta, \gamma]$

- Operate
  $V_i \in [D, P/\eta]$

- Operate
  $V_i + f(D, V_i; \theta)$
Optimal Debt Choice

Competitive firms take the price of liquidated assets, $P$, as given:

$$\max_D V_0(D) \equiv \frac{1}{\gamma} \cdot \left\{ \int_0^\Lambda P \, dV + \int_\Lambda^D \left[ V - \phi \cdot (D - V) \right] \, dV + \int_D^\gamma V \, dV \right\}$$

$$+ \frac{1}{\gamma} \cdot \left\{ \ell(D) \cdot \int_{P/\eta}^\gamma (\gamma - P/\eta) \, dV \right\} + \tau \cdot D .$$

Key novel feature: $P$ is determined endogenously

- Aggregate supply: $\frac{\Lambda(P,D)}{\gamma}$
- Aggregate demand: $\ell(D) \cdot \left( \frac{\gamma - P/\eta}{\gamma} \right)$

A symmetric equilibrium at time 0 is defined by:

- Given $\{P, \Lambda^*\}$, firms choose debt $D$, to maximize firm value at time 0;
- The price $P$ clears the market for liquidated assets at time 1.
Marginal Impact of D

1. Tax benefits: $\tau$

2. Costs of financial distress: $\phi \cdot (D - \Lambda)$

3. Distressed asset buying opportunities: $\ell'(D) \cdot \int_{P/\eta}^{\gamma} (\eta \cdot V - P) \, dV$
   - Debt overhang reduces ability to raise financing $\ell'(D) < 0$
   - Strategic benefit of low debt ("dry powder") is greater when future buying opportunities are likely to be attractive: $\eta$ and $\gamma$ are high and $P$ is low
Assume (i) unlimited capital availability and (ii) efficient continuation in default

- Highest productivity firm buys all low-productivity assets
- Surplus is competed away so liquidating firms receive full value (no fire sales)
- Remaining tradeoff: tax shields vs. costs of financial distress

There is a unique symmetric equilibrium \( \{D^*, P^*\} \) where

\[
D^* = (\eta + \tau + \tau/\phi) \cdot \gamma,
\]

\[
P^* = \eta \cdot \gamma,
\]
### Comparative Statics

<table>
<thead>
<tr>
<th>Exog $\rightarrow$</th>
<th>Distress Costs $\phi$</th>
<th>Tax Benefits $\tau$</th>
<th>Asset Redeployability $\eta$</th>
<th>Firm Scale $\gamma$</th>
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<tr>
<td>Endog $\downarrow$</td>
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$P^* = \eta \cdot \gamma$

- Debt provides tax shield benefit
- But, higher debt implies firms liquidate too often compared to first-best ($\Lambda > \eta \cdot \gamma$)
- And, higher debt implies greater dissipative distress costs
Introduce third force: distressed asset buying opportunities provides an incentive to limit debt (continue to assume efficient continuation)

There is a unique symmetric equilibrium \( \{ D^*, P^* \} \) where

\[
D^* = \gamma \cdot \left[ \frac{k(1+\phi) \cdot \left( \frac{1+\frac{\alpha(1+\phi)}{\phi \eta}}{(1+k(1+\phi)/\eta)} \right)}{1 + \left( 1 + \frac{\alpha(1+\phi)}{\phi \eta} \right) \cdot \left( \frac{\phi + 2\alpha(1+\phi)/\eta}{1+K(1+\phi)/\eta} \right)} \right] + \frac{(1+\phi)(\tau-\alpha)}{\phi}
\]

\[
P^* = \left[ \frac{k(1+\phi)}{1+k(1+\phi)/\eta} \right] \cdot \gamma - \left[ \frac{\phi + 2\alpha(1+\phi)/\eta}{1+k(1+\phi)/\eta} \right] \cdot D^*
\]
## Comparative Statics

<table>
<thead>
<tr>
<th>Exog →</th>
<th>Distress Costs</th>
<th>Tax Benefits</th>
<th>Asset Redeployability</th>
<th>Funding Availability</th>
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<tr>
<td>Endog ↓</td>
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<td>$P^*$</td>
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### Definitions:
- **$D^*$**: Distress Tax Asset Funding
- **$V^*$**: Exogenous Costs
- **$P^*$**: Availability
- **$D^*/V^*$**: Redeployability

### Notes:
- The table shows the comparative statics for the given variables.
- The symbols indicate the direction of change: + for increase, − for decrease, −/+ for mixed change.

### Equations:
- $D^* - + + + -$
- $V^* - + + + -$
- $D^*/V^* - / + −/+ +$
- $P^* + − + + −/+ +$
Comparison to benchmark model

**Asset specificity**
- Direct effect: Less specific (more redeployable) assets have higher liquidation values ⇒ lower distress costs ⇒ higher debt (Williamson, 1988)
- Indirect effect: Better future buying opportunities when assets are less specific ⇒ strategic motive to keep debt low (because of debt overhang)

**Tax shield benefit**
- Direct effect: Higher tax shields ⇒ higher debt
- Indirect effect: Higher debt ⇒ lower liquidation values ⇒ greater future buying opportunities ⇒ strategic motive to keep debt low
Shleifer and Vishny (1992) argues that liquidation values are particularly sensitive to industry conditions because the natural buyers of liquidated assets are also likely to be distressed.

Extend the model to allow industry booms and busts:

\[
\begin{align*}
\gamma_H &= \gamma + \Delta \quad \text{w.p. 1/2} \\
\gamma_L &= \gamma - \Delta \quad \text{w.p. 1/2}
\end{align*}
\]
There is a unique symmetric equilibrium \( \{ D_{HL}, P_H, P_L \} \) where

\[
D_{HL} = \left(1 - \frac{\Delta^2}{\gamma^2}\right) \cdot D^*
\]

\[
P_H = \left[\frac{k(1+\phi)}{1+k(1+\phi)/\eta}\right] \cdot (\gamma + \Delta) - \left[\frac{\phi + 2\alpha(1+\phi)/\eta}{1+k(1+\phi)/\eta}\right] \cdot D_{HL}
\]

\[
P_L = \left[\frac{k(1+\phi)}{1+k(1+\phi)/\eta}\right] \cdot (\gamma - \Delta) - \left[\frac{\phi + 2\alpha(1+\phi)/\eta}{1+k(1+\phi)/\eta}\right] \cdot D_{HL}
\]

where \( D^* \) is optimal debt without industry uncertainty.
Predictions

- Optimal debt is lower when there is more uncertainty about the industry state
- *Holding future cash flows constant*, the liquidation price is lower in the industry recession state (Acharya, et al., 2007) – less aggregate demand
- Probability of liquidation conditional on distress is lower in the recession state (Acharya, et al., 2007) – lower prices make reorganization more desirable
- Unconditional probabilities of distress and liquidation are independent of uncertainty about the industry state
  - greater uncertainty $\Rightarrow$ greater downside risk $\Rightarrow$ higher likelihood of distress
  - greater uncertainty $\Rightarrow$ lower debt $\Rightarrow$ lower likelihood of distress
- Two effects exactly offset in our model
shareholders can capture $\beta$ share of continuation value in default, e.g., risk-shifting ($\beta \geq 0$ measures strength of debtor rights)

$\Rightarrow$ management has an incentive to default strategically, $\hat{D} > D$

$\Rightarrow$ absent renegotiation, management will always choose to continue in default

bondholders make a take-it-or-leave-it offer to pay $x$ to shareholders if assets are liquidated

$\Rightarrow$ management will choose to liquidate when $V_i$ is below some threshold, $V_i \leq \Lambda(x)$
Resolution of Financial Distress at Time 1

Optimal Transfer

\[
\max_x \frac{1}{\hat{D}} \int_{0}^{\Lambda(x)} (P - x) dV + \frac{1}{\hat{D}} \int_{\Lambda(x)}^{\hat{D}} (1 - \beta) \cdot [V - \phi(\hat{D} - V)] dV
\]

\[
\Rightarrow x^* = \frac{\beta \cdot (P - \phi \beta \hat{D})}{1 + \beta}
\]

Liquidation Threshold

\[
\Lambda^* = \frac{P + \phi \hat{D}}{(1 + \beta)(1 + \phi)} \leq \Lambda_{\text{eff}} = \frac{P + \phi \hat{D}}{(1 + \phi)}
\]

Strategic default boundary

\[
\hat{D}^* = \frac{D^*}{1 - \beta}
\]
Introduce fourth force: Inefficient continuation ($\beta > 0$)

- **Direct effect:** Stronger debtor rights $\Rightarrow$ greater distress costs $\Rightarrow$ lower debt
- **Indirect effect:** Stronger debtor rights $\Rightarrow$ lower supply of liquidated assets $\Rightarrow$ higher liquidation values $\Rightarrow$ less strategic motive for keeping debt low
- Stronger debtor rights may increase or decrease debt levels and debt ratios
If we assume $E[r] = 0$ and tax shield benefits flow to equity then the promised rate of return on debt, $r$, solves:

$$\frac{D^*}{1 + r} = \frac{1}{\gamma} \cdot \left\{ \int_0^{\Lambda^*} (P^* - x^*) \, dV + \int_{\Lambda^*}^{\hat{D}^*} (1 - \beta) [V - \phi \cdot (\hat{D}^* - V)] \, dV + \int_{\hat{D}^*}^{\gamma} D^* \, dV \right\}$$

**Credit spreads**

- increase in tax shield benefit - firm takes on more debt (riskier)
- may increase or decrease in distress costs - firms respond by lowering debt (as in Leland, 1994)
- may increase or decrease in redeployability - firms may respond by increasing debt
- may increase or decrease in debtor rights - firms may respond by decreasing debt