Trade Credit and Capital Structure

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(Joint work with Song (Alex) Yang, London Business School, and Xiaodong Xu, BNP Paribas)

The University of Chicago
Booth School of Business

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Themes

- Trade credit plays a key role in supply chain finance
- Trade credit provides a flexible risk-sharing mechanism
- Tax advantages of debt and distress costs imply optimal capital structure choices
- Early commitment considerations in supply chains lead to different implications from traditional analyses
- Empirical results support the theory
How to view trade credit?

The credit suppliers extend to buyers. Accounts Receivable (suppliers) and Accounts Payable (buyers).

Net (one-part) terms net 30: payment is due within 30 days.

Two-Part Terms 2/10 net 30: payment is due within 30 days, if paid within 10 days, 2% discount applies.
How to view trade credit?

- The retailer places an order.
- The order is delivered.
- The supplier proposes a contract.
- Payment is due.
- Demand is realized.
- Time

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Net (one-part) terms
- net 30: payment is due within 30 days.

Two-Part Terms
- 2/10 net 30: payment is due within 30 days, if paid within 10 days, 2% discount applies.
Trade Credit across Industries

- Trade credit (payables) vary by industry
- Payable days generally increase in value of goods
- Strong relationship with inventory days

**Figure 1** Payable Days versus Inventory Days by Sub-category

Payable Days = 18.3 + 0.26 Inventory Days

(2.44)  (3.01)

Another important observation from Figure 1 is that many firms have payable days longer than one month. Given the fact that firms in our sample normally have easy access to other financing sources, they probably would not use large amounts of trade credit if trade credit is expensive. In contrast, survey data (Ng et al. 1999) alludes that the implicit interest on trade credit is surprisingly high. For example, as an often used trade credit term, “2/10 net 30” (trade credit has to be paid off in thirty days; if paid in ten days, a two percent discount applies), implies an annualized interest of about 44 percent if the early discount is forgone. At a minimum, we can conclude from these conflicting pieces of evidence that the interest on trade credit is widely dispersed; thus two natural questions follow: Why do some companies enjoy cheap trade credit while others face trade credit with high cost? What drives the interest on trade credit?

Despite its wide and common usage, trade credit alone is insufficient to finance inventory, as shown in Figure 1. Hence retailers must employ other internal or/and external sources to finance inventory. Therefore, when discussing how inventory is financed, we are looking at a portfolio that may consist of cash, trade credit, and short-term debt. In this context, questions of interest include: What is the structure of this inventory financing portfolio? How does this structure change according to such factors as the retailer’s and the supplier’s characteristics and the overall efficiency of the financial market?

To answer the above questions, we build a stylized model based on the classical “selling to the newsvendor” setting. The upstream firm, which we call the supplier, behaves as the leader in the Stackelberg game, and the downstream firm (the retailer) as the follower. To explicitly model financial constraints and related costs yet retain our focus on operations, we introduce a perfectly...
Trade Credit and Operations

- Trade credit: The single largest source of short-term financing in U.S.
  - Rajan and Zingales (1995): 15% (vs. debt in current liability (7.4%));
- Operations deal with short-term decisions: inventory, pricing, etc.
- Trade credit links firms’ financial flows; supply chain links firms’ material and information flows
- How should trade credit be studied in a supply chain setting?

Main Findings (Yang and Birge 2009)

- Trade credit serves as a risk-sharing mechanism in supply chains;
- The optimal trade credit term balances operational profits and costs of financial distress;
- Retailers finance their inventory using a portfolio of cash, trade credit, and short-term debt.

Figure: balance sheet items as a fraction of total assets (median)

Main Findings (Yang and Birge 2009)

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However ...

Treat trade credit as given, why?
- Quoted: net 30, or 2/10 net 30
- Reported mismatch: Ng et. al (1999)

In actuality:
- Discounts or terms exaggerated: Antov and Atanasova (2007)
- Large variation in balance sheet positions
- Terms difficult to enforce

Our view: trade credit is a mechanism to improve supply chain performance (and possibly equity market performance (Cohen and Frazzini (2009))
- Trade credit allows for productive risk sharing
- Markets appear to be slow to incorporate supply chain effects into prices
- Supply-chain partner connections can be informative
Problems Addressed in Research Project

- Why do firms use trade credit?
- How can firms use trade credit as a mechanism to improve supply chain performance?
- How does trade credit perform relative to other forms of financing?
- What is the effect of different seniority for different forms of credit and should one be preferred?
- What is the effect of multiple suppliers on supply chain performance with trade credit?
Literature

- Theory of trade credit

- Transaction cost: Ferris (1981)
- Price discrimination: Brennan et al. (1988)

- Empirical support: financing, default, price, quality (e.g., Klapper, Laeven, and Rajan (2010))

- Priorities/Reclamation Rights
  - Garvin (1996), Katz and Dion (2005), Morris (2007)

- Operations-Finance interaction
  - Irrelevance results of Modigliani and Miller (1958)
  - Supply chain effects: Gupta (2008), Lai et al. (2009), Kouvelis and Zhao (2009), Caldentey and Chen (2009)
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1 Background

2 The Basic Trade Credit Model

3 Empirical Tests

4 Multiple Creditors and Priority Rules

5 Capital Structure Model

6 Conclusion
Problems with Fixed Wholesale Prices versus Trade Credit

- Capital Utilization:
  - Lower financing cost may be possible with trade credit

- Risk-sharing:
  - With up-front payment, risk is not shared efficiently
  - Chain profits are reduced by double marginalization without risk sharing

- Result:
  - Suppliers may improve profits with trade credit contract
Model of a Two-part Trade Credit Contract

 Suppliers propose:
  - \( w_1 \): cash price, paid upon delivery
  - \( w_2 \): credit price, only paid in full when no bankruptcy

 Buyer responds:
  - Order cash and credit amounts: \( x_1 \) and \( x_2 \)
  - Borrow from the bank: \( D = w_1 x_1 - (K - C_f) \)
Results:
- As buyer’s cash position increases, supplier’s profit improves but buyer’s profit does not always improve.
- Fully coordinating only when no loan is needed.

<table>
<thead>
<tr>
<th>Monotone Results under the Optimal Price-Only Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_r \uparrow$</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>$(0, \kappa_{bw})$</td>
</tr>
<tr>
<td>$(\kappa_{bw}, \kappa_{nb})$</td>
</tr>
<tr>
<td>$(\kappa_{nb}, \infty)$</td>
</tr>
</tbody>
</table>

Optimal Wholesale Contract with Bank Loan

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(Birth (Chicago Booth))
Result with Trade Credit: No Fixed Costs/Other Debts

Assumption:

\[(K - C_f) \geq 0: \text{Buyer does not need to borrow if suppliers extend full credit}\]

Result:

- Suppliers propose *open account*: \(w_1 = w_2\) (no-interest loan)
- Buyers use full credit facility: \(x = x_2\)
The Basic Trade Credit Model

Additional Cost Implications: Seniority Matters

- The Basic Framework:
  - Risk-neutral (equivalent) parties;
  - Supplier offers open account contract with price $w$;
  - Retailer with cash position, $K_R \leq 0$, responses with quantity $x$, and borrows $B$ from the bank;
  - Perfect financial market;

- Basic Result: $B + K_R = 0$.

- Focus: How does seniority matter?
  - Bank Loan is Senior;
  - (Leftover) Inventory As Bank Loan’s Collateral;
  - Equal Seniority;
Supplier receives nothing until bank loan and factoring (if any) are fully paid off.

Total losses to distress costs can be lowered by maintaining hierarchy of seniority.
How Trade Credit Extends Efficiency

- Bank loan increases buyer’s capability but at higher cost
- Trade credit increases buyer’s capability but the cost becomes lower (as some is shared with creditors)

Marginal Revenue vs. Marginal Cost for the Retailer: Cases with Different Sources of Financing

I: no leverage
II: levered with only a bank loan
III: moderately levered with cheap trade credit
IV: highly levered with both a bank loan and trade credit
Supply Chain Performance with Trade Credit

- As buyer’s capital increases, supplier’s profits decline while retailer’s profits rise.
- As buyer’s capital increases, the offered price and the order quantity decline.

![Optimal Trade Credit Contract: Supply Chain Performance](image-url)
General Conclusions from Simple Single Supplier-Buyer Model

- Trade credit improves supplier’s profit when junior to bank loan
- Buyer’s profit can also increase with trade credit if the buyer has sufficient cash
- Hypotheses for empirical study:
  - Trade credit (payables) should increase with buyer’s inventory holdings
  - Trade credit should be more highly correlated with inventory for buyer’s with greater seasonal inventory variation
  - Bank loans (current debt) should not vary with buyer’s inventory positions for buyer’s with low seasonal inventory variation
  - Bank loans (current debt) should increase with buyer’s inventory positions for buyer’s with high seasonal inventory variation
Regression for Hypothesis Testing

- Regression equations:

\[ \Delta Payable^t = \alpha_{pay}^t + \beta_{pay}^t \Delta INV^t + \epsilon_{pay}^t \]
\[ \Delta CDebt^t = \alpha_{debt}^t + \beta_{debt}^t \Delta INV^t + \epsilon_{debt}^t \]

- Sort by inventory variation
  - High (33% of sales in Q4)
  - Low (26% of sales in Q4)

Descriptive Statistics

<table>
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<tr>
<th>Assets ($ Million)</th>
<th>Balance Sheet Items as a Fraction of Total Assets</th>
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<tbody>
<tr>
<td></td>
<td>Inventory</td>
</tr>
<tr>
<td>Mean</td>
<td>2730.0</td>
</tr>
<tr>
<td>Q1</td>
<td>142.1</td>
</tr>
<tr>
<td>Q2</td>
<td>424.5</td>
</tr>
<tr>
<td>Q3</td>
<td>1561.7</td>
</tr>
</tbody>
</table>
Empirical Tests

Payable Days across Firms and Industries

![Cumulative Distribution of Payable Days](image)

| Quartiles of Accounts Payable Days and Inventory Days by Subcategory in Retail |
|-----------------------------|------------------|-----------------|-----------------|-------------------|-------------------|
| Subcategory in Retail       | Num. of Firm-Years | Payable Days | Inventory Days  |
| (North America Industry Classification System) | Q₁  | Q₂  | Q₃  | Q₁  | Q₂  | Q₃  |
| All Retailers               | 2127 | 27.8 | 41.1 | 58.8 | 51.5 | 86.0 | 134.6 |
| Motor Vehicle and Parts Dealers (441) | 183  | 5.7  | 13.2 | 66.9 | 56.4 | 77.9 | 191.6 |
| Furniture and Home Furnishings Stores (442) | 62   | 34.1 | 57.9 | 70.4 | 92.8 | 116.4 | 146.1 |
| Electronics and Appliance Stores (443) | 97   | 33.3 | 39.4 | 49.8 | 35.0 | 67.4 | 109.8 |
| Building Material and Garden Equipment and Supplies Dealers (444) | 68   | 24.4 | 34.9 | 50.3 | 62.1 | 83.0 | 110.4 |
| Food and Beverage Stores (445) | 156  | 21.6 | 25.6 | 37.6 | 25.8 | 34.1 | 40.2 |
| Health and Personal Care Stores (446) | 155  | 30.2 | 42.8 | 63.0 | 14.9 | 48.9 | 95.0 |
| Gasoline Stations (447) | 31   | 8.3  | 18.3 | 28.0 | 8.8  | 13.0 | 16.5 |
| Clothing and Clothing Accessories Stores (448) | 543  | 29.5 | 38.8 | 52.6 | 73.2 | 91.4 | 134.2 |
| Sporting Goods, Hobby, Book, and Music stores (451) | 208  | 49.3 | 62.5 | 88.5 | 119.2 | 153.4 | 181.1 |
| General Merchandise Stores (452) | 259  | 31.3 | 41.5 | 52.3 | 81.0 | 107.3 | 142.6 |
| Miscellaneous Store Retailers (453) | 109  | 27.1 | 41.3 | 49.3 | 57.3 | 84.8 | 113.6 |
| Nonstore Retailers (454) | 256  | 32.2 | 48.0 | 64.0 | 22.7 | 55.3 | 103.6 |
Regression Results

Hypotheses:

\[ \beta_{pay}^H > \beta_{pay}^L > 0 \]
\[ \beta_{debt}^H > \beta_{debt}^L = 0 \]

Table 5 presents the regression results. The first two columns show the results of the basic regression, and the other columns add ∆Receivable and ∆Cash & Eq as independent variables. Several important results follow. First, in panel A, when inventory changes, the payable change in the high group (\( \beta > 0.6 \)) and in the low group (\( \beta < -0.4 \)) are both statistically and economically significant, suggesting companies with higher leverage use more accounts payable to finance inventory. In addition, \( R^2 \) in the high group is much larger than that in the low group. Adding changes in cash and receivable as independent variables does not alter this result. Second, in panel B, the influence of inventory change on the level of short term debt is barely significant in the low group (t-stat ≈ 2 and \( R^2 \approx 0 \)), whereas the influence is much stronger in the high group (t-stat > 8 and \( R^2 > 5 \% \)). By adding ∆Cash & Eq as an independent variable, the influence in the high group remains the same, whereas that in the low group becomes insignificant (t-stat < -0.5). This finding again suggests that during the regular period, companies use little short-term debt to finance inventory. However, during the period with high leverages, they use some short-term debt, making the inventory financing portfolio more diversified.

<table>
<thead>
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<th>Panel A: ∆Payable Regression</th>
<th>Panel B: ∆Ct. Debt Regression</th>
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<tr>
<td>∆Inventory</td>
<td>L 0.37 H 0.62</td>
<td>L 0.12 H 0.35</td>
</tr>
<tr>
<td></td>
<td>(14.48) (26.57)</td>
<td>(2.10) (9.15)</td>
</tr>
<tr>
<td>∆Receivable</td>
<td>L 0.19 H 0.19</td>
<td>L 0.20 H 0.25</td>
</tr>
<tr>
<td></td>
<td>(5.51) (2.98)</td>
<td>(5.59) (4.01)</td>
</tr>
<tr>
<td>∆Cash &amp; Eq.</td>
<td>L 0.19 H 0.21</td>
<td>L -0.40 H 0.10</td>
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<tr>
<td></td>
<td>(5.59) (4.01)</td>
<td>(-6.48) (2.53)</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.16 0.40</td>
<td>0.00 0.07</td>
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6. Conclusion

This paper addresses an important question that has received little attention in the operations community: As an integrated part of a supply chain contract, what role does trade credit play in a supply chain? Both the analytical model and empirical evidence lead to the conclusion that an essential role of trade credit is to act as a risk-sharing mechanism and mitigate the mismatch of...
Background

The Basic Trade Credit Model

Empirical Tests

Multiple Creditors and Priority Rules

Capital Structure Model

Conclusion
**Comparisons to Theory**

- **Theoretical model (trade-credit/bank loan vs. financing need):**

![Diagram showing inventory financing portfolio and early discount](image)

- **Empirical results (payables/short-term debt beta vs. financing need):**

![Graphs showing beta vs. financing need](image)
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Extension: Multiple Suppliers and Other Risks

- Suppliers share in the risk of each other’s product’s demand even if demands are independent

Questions:
- Does the advantage of trade credit extend in these cases?
- How should priority of claims be set?

Basic Results:
- Buyers and suppliers still have an advantage from trade credit
- Suppliers generally should prefer to be junior to bank loans

Additional complications with other financial claims (e.g., long-term or credit secured with other assets)
Relationship to Capital Structure

- Debt (trade and other) has tax advantage but causes distress
- Traditional models consider the tradeoff but provide often not early production commitment
- Early commitment effects lead to different relationships
- Can observe the relationship with profitability and inventory
Basic Model

- Decisions: Debt $D_t$, equity $E_t$, capacity investment (orders) $x_t$, sales $y_t$, and continuation (or bankruptcy $s^b$)
- Financial distress: Proportional deadweight cost $\alpha$
- Tax rates on profits $\tau$
- Random process $\omega_t$ for demand $s_t$, unit cost $c_t$, loan rate $r_t$, fixed costs $K_t$
- Competitive financial market, no issuing costs

\[
V_t(k_t, D_{t-1}, \omega^t) = \max_{x_t, y_t, s^b, D_t, E_t} \left\{ 0, -c_t x_t - K_t \right. \\
+ \frac{1}{1+r_f} \left( \int_{y_t}^{\infty} (p_t y_t - \tau (p_t y_t - c_t x_t - r_t D_t - K_t)) f_t(s) \, ds \right. \\
+ \int_{s^b}^{s^*} (p_t s - \tau (p_t s - c_t x_t - r_t D_t - K_t)) f_t(s) \, ds \\
+ \left. \frac{1}{1+r_f} \int_{s^b}^{s^*} p_t s f_t(s) \, ds + \alpha \int_{s^b}^{s^*} p s f_t(s) \, ds \right. \\
\left. + E_s(E_{\omega^t+1}|(s, \omega^t)[V_{t+1}(k_{t+1}(y_t, s), D_t, \omega^t+1)]) \right) \\
\right. \\
\text{subject to} \quad D_t = \frac{1+r_t}{1+r_f} (D_t[1 - F_t(s^b)] + \alpha \int_{s^b}^{s^*} p_t s f_t(s) \, ds, \\
\quad x_t + k_t = y_t, \quad 0 \leq c_t x_t + K_t \leq \frac{1}{1+r_t} D_t + E_t - D_{t-1}, \\
\quad (5.1)
\]
Model Implications

- Firm value is more sensitive to mis-specification of the operational decisions $x_t$ than to the equity and debt decisions $E_t$ and $D_t$.

- Market leverage (ratio of debt to market value $V_t$) has a convex relationship to firm margins as measured by $p_t - c_t$ with initial negative relationship between leverage and margins for low margins.

- Leverage may then increase in operating margin for high margin values.

- As fixed costs rise, leverage should decrease.

- Since observed firms with large losses are more likely to have expected high operating margins, operating margins are most likely decreasing in “profits” of firms with substantial losses and then increasing.

- Combining the implications on profitability, leverage should first increase in observed profits (as a fraction of sales) and then follow a convex or U-shaped relationship.
### Implied relationship

- High-fixed cost firms with high but decreasing margins as observed profit increases
- Low-fixed cost firms with increasing margins in observed profit
- Combination of increases-decrease-increase for observed leverage
Hypotheses to Test

- H1: Firms with operating losses exhibit an increasing relationship between debt-to-market-value ratio and pre-tax operating margin.
- H2: Firms with low positive operating margins exhibit a decreasing relationship between debt-to-market-value ratio and pre-tax operating margin.
- H3: Firms with high positive operating margins may exhibit an increasing relationship between debt-to-market-value ratio and pre-tax operating margin, depending on the distribution of demand for the firm’s products or services.
- H4: The volatility of inventories is initially decreasing in operating margin as firm losses decrease to zero and then increases as operating margin becomes significantly positive.
Empirical results

- Compare pre-tax operation margin and market leverage using Value Line and Compustat firms
- Compare within years and within industry

Table: Average market leverage by pre-tax operating margin deciles 2006 (Value Line).

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<td>Decile</td>
<td>Max pre-tax op. margin</td>
</tr>
<tr>
<td>1</td>
<td>-128.68%</td>
</tr>
<tr>
<td>2</td>
<td>-11.95%</td>
</tr>
<tr>
<td>3</td>
<td>1.22%</td>
</tr>
<tr>
<td>4</td>
<td>5.49%</td>
</tr>
<tr>
<td>5</td>
<td>8.92%</td>
</tr>
<tr>
<td>6</td>
<td>12.41%</td>
</tr>
<tr>
<td>7</td>
<td>16.19%</td>
</tr>
<tr>
<td>8</td>
<td>22.24%</td>
</tr>
<tr>
<td>9</td>
<td>33.67%</td>
</tr>
<tr>
<td>10</td>
<td>100.00%</td>
</tr>
</tbody>
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Empirical Relationship

- Leverage versus deciles of pre-tax operating margin/sales
- Consistent for each year, industry, and dataset
H4: The volatility of inventories is initially decreasing in operating margin as firm losses decrease to zero and then increases as operating margin becomes significantly positive.

**Table**: Average of CoV of inventory by average pre-tax operating margin deciles over the period 1996-2005. \((N = 1513)\)

<table>
<thead>
<tr>
<th>Decile</th>
<th>Average CoV of Inventory</th>
<th>Test statistic</th>
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<tr>
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<tr>
<td>2</td>
<td>0.553</td>
<td>−6.056****</td>
</tr>
<tr>
<td>3</td>
<td>0.441</td>
<td>−1.868**</td>
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<tr>
<td>4</td>
<td>0.484</td>
<td>0.683</td>
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<tr>
<td>5</td>
<td>0.467</td>
<td>−0.247</td>
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<tr>
<td>6</td>
<td>0.414</td>
<td>−0.852</td>
</tr>
<tr>
<td>7</td>
<td>0.575</td>
<td>2.306**</td>
</tr>
<tr>
<td>8</td>
<td>0.534</td>
<td>−0.580</td>
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<tr>
<td>9</td>
<td>0.644</td>
<td>1.853**</td>
</tr>
<tr>
<td>10</td>
<td>1.080</td>
<td>4.634****</td>
</tr>
</tbody>
</table>
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Additional Questions

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Birge (Chicago Booth)

The Role of Trade Credit and Capital Structure in Supply Chains
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- Does order quantity actually decline with buyer’s cash position (as the basic model predicts)?
Conclusions

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6. Leverage is consistent with a tradeoff theory that includes early commitment of resources before the realization of demand uncertainty.
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