The Risk-Sharing Role of Trade Credit in Supply Chains with Demand Uncertainty and Costs of Financial Distress

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Wilfred Laurier University
November 9, 2012
What is TRADE CREDIT?

The credit suppliers extend to retailers.

Accounts Receivable (suppliers) and Accounts Payable (retailers).

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.
What is TRADE CREDIT?

The supplier proposes a contract.
The retailer places an order.

The order is delivered.
Payment is due.

Demand is realized.

Time

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Birge and Yang (ChicagoBooth and LBS) The Risk-Sharing Role of Trade Credit in Supply Chain Wilfred Laurier (Nov. 2012) 2 / 41
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Trade Credit
Why use trade credit?

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How to finance inventory?
An (inventory) risk-sharing mechanism

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How to finance inventory?
A portfolio of cash, trade credit, and short-term debt

Rajan and Zingales (1995): 15% of total assets (debt in current liabilities: 7.4%).

Our data: Compustat North America quarterly financial statements retailers (NAICS code: 441 - 454) period: 1999 - 2008, fiscal year ends at Dec 31st or Jan 31st total 2,117 firm-years median size: $424 million

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

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Trade Credit Can Be Risky!

On November 10th, 2008, Circuit City filed for bankruptcy. Total accounts payable: $754.5 million (total liabilities: $2.32 billions) Out of its 50 largest unsecured creditors, 48 were trade creditors. 

48th (Kingston): $1.65 million 
3rd (Sony): $60.01 million 
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The “Flexibility” in Trade Credit

Days Payable

Cumulative Distribution

2/10 Net 30
The “Flexibility” in Trade Credit

2/10 Net 30

All Firm
(N = 2127)
The “Flexibility” in Trade Credit

![Cumulative Distribution Chart]

- 2/10 Net 30 (N = 2127)
- All Firm (N = 2127)
- Cash/Sales >0.05 (N = 675)

Birge and Yang (Chicago Booth and LBS)

The Risk-Sharing Role of Trade Credit in Supply Chains

Wilfred Laurier (Nov. 2012)
# Flexibility within a Subcategory

<table>
<thead>
<tr>
<th>Subcategory in Retail (North America Industry Classification System)</th>
<th>Num. of firm-years</th>
<th>Days Payable</th>
</tr>
</thead>
<tbody>
<tr>
<td>All retailers</td>
<td>2127</td>
<td>27.8</td>
</tr>
<tr>
<td>Motor vehicle and parts dealers (441)</td>
<td>183</td>
<td>5.7</td>
</tr>
<tr>
<td>Furniture and home furnishings stores (442)</td>
<td>62</td>
<td>34.1</td>
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<td>Electronics and appliance stores (443)</td>
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<td>33.3</td>
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<td>Building material and garden equipment and supplies dealers (444)</td>
<td>68</td>
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<td>156</td>
<td>21.6</td>
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<td>Health and personal care stores (446)</td>
<td>155</td>
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The Risk-Sharing Role of Trade Credit in Supply Chains

Birge and Yang (ChicagoBooth and LBS)
What Should We Know About Trade Credit?

Trade Credit and Inventory

Days Payable = 18.3 + 0.26 Days Inventory
(t-stat) (2.44) (3.01)

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Net 30

441 (Motor vehicle and parts dealers)

Birge and Yang (ChicagoBooth and LBS) The Risk-Sharing Role of Trade Credit in Supply Chain
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Net 30
Consignment

441 (Motor vehicle and parts dealers)
The supplier proposes a contract.

The order is delivered.

Net period

Discount applies.

Demand is realized.

Payment is due.

Discount period

The retailer places an order.

Limited internal capital (cash): $K_r$ (the retailer), $K_s$ (the supplier)

A bank loan is available.

"Selling to the newsvendor": one supplier with production cost $c$, one retailer with retail price $p = 1$, salvage value $s = 0$.

One type of goods, all three parties know and agree on demand distribution $\xi \sim F(y)$ ($f(y), \bar{F}(y) = 1 - F(y), g(y) = y f(y) \bar{F}(y)$).

All parties are risk-neutral (or equivalent risk-neutral measure).

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Revenue

\[ x_t \]: how much to order
Revenue is the **ONLY** income.

- \( x_t \): how much to order

**Diagram:**

- **Axes:**
  - X-axis: Demand
  - Y-axis: Revenue

- **Points:**
  - \( x_t \) on the X-axis
  - \( x_t \) on the Y-axis

- **Line:**
  - Represents the relationship between demand and revenue.

**Equation:**

\[
\text{Revenue} = \text{Demand} \\
\text{Revenue} = x_t \text{ Demand} \]

**Variables:**

- \( x_t \): how much to order
- \( \theta \): trade credit threshold
- \( \theta_{rb} \): how much to pay back to the bank (bank loan threshold)

**Notes:**

- Revenue is the **ONLY** income.
- \( x_t \): how much to order
- Trade credit is contingent on realized demand when \( \xi < \theta_{tc} \)
- \( \theta_{rb} \) is the bank loan threshold.
Revenue is the **ONLY** income.

\[
x_t: \text{how much to order}
\]
Relevance is the ONLY income.

Realized demand is NOT contractible.

\( x_t \): how much to order
- Revenue is the **ONLY** income.
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- The bank loan is **senior** to trade credit.

$x_t$: how much to order

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**Revenue**

**Demand**
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- The bank loan is senior to trade credit.

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\[ \theta_{rb} : \text{how much to pay back to the bank (bank loan threshold)} \]
\[ \theta_{tc} : \text{trade credit threshold} \]
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- Upon default, \((1 - \alpha)\) of the value is lost as costs of financial distress.

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- The bank loan market is **perfectly competitive**.

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- \(\theta_{tc}\): trade credit threshold

\[\text{Revenue} = \alpha \int_{\theta_{rb}}^{\theta_{tc}} \xi dF(\xi) + \theta_{rb} \bar{F}(\theta_{rb}) = \int_{\theta_{rb}}^{\theta_{tc}} \bar{F}(\xi; \alpha) d\xi.\]
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Bank loan pricing \((r_f = 0)\):

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(w_1 x_1 - K_r)^+ = \alpha \int_0^{\theta_{rb}} \xi dF(\xi) + \theta_{rb} \bar{F}(\theta_{rb})
\]

- **\(x_t\)**: how much to order
- **\(\theta_{rb}\)**: how much to pay back to the bank (bank loan threshold)
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= \int_0^{\theta_{rb}} \bar{F}_d(\xi; \alpha) d\xi.
\]

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**Bank loan pricing** $(r_f = 0)$:

$$
(w_1 x_1 - K_r)^+ = \alpha \int_0^{\theta_{rb}} \xi dF(\xi) + \theta_{rb} \bar{F}(\theta_{rb})
$$

$$
= \int_0^{\theta_{rb}} \bar{F}_d(\xi; \alpha) d\xi.
$$

**Trade credit**:

- **amount**: $w_2 x_2 = \theta_{tc} - \theta_{rb}$

**Variables**:

- $x_t$: how much to order
- $\theta_{rb}$: how much to pay back to the bank (bank loan threshold)
- $\theta_{tc}$: trade credit threshold
• Revenue is the **ONLY** income.
• Realized demand is **NOT** contractible.
• The bank loan is **senior** to trade credit.
• Upon default, $(1 - \alpha)$ of the value is lost as costs of financial distress.
• The bank loan market is **perfectly competitive**.

Bank loan pricing ($r_f = 0$):

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• **Trade credit:**
  • amount: $w_2 x_2 = \theta_{tc} - \theta_{rb}$
  • “contingent” on realized demand when $\xi < \theta_{tc}$

\[x_t: \text{ how much to order}\]
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- Newsvendor model:
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- Loan terms are endogenously determined by inventory decisions; (Leland 1994)

Seniority/priority: practice (Schwartz 1997) efficiency
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Literature

- Theory of trade credit
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- Theory of trade credit

- Supply chain contracting
Literature

- **Theory of trade credit**

- **Supply chain contracting**
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  - irrelevance results of Modigliani and Miller (1958)
  - supply chains: Gupta (2008), Lai et al. (2009), Kouvelis and Zhao (2009), Caldentey and Chen (2009)
The Retailer’s Response (Fixing Discount Price $w_1$)

- No external financing:
  \[ F(x_1) = w_1; x_2 = 0. \]

- Only a bank loan:
  \[ F(x_1) = w_1 - (1 - \alpha)g(\theta_{rb}); x_2 = 0. \]

- Trade credit and a bank loan:
  \[ F(x_t) = w_2 \bar{F}(\theta_{tc}); \bar{F}_d(\theta_{rb}, \alpha) = w_1w_2 (= 1 - dtc). \]
The Retailer’s Response (Fixing Discount Price $w_1$)

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Though the text is mostly in English, there are some equations and diagrams that are not clearly transcribed into natural text.
The Retailer’s Response (Fixing Discount Price $w_1$)

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\begin{align*}
\bar{F}(x_1) &= w_1; \\
x_2 &= 0.
\end{align*}

\[ \text{Early Discount (dtc)} \]
\[ \text{Retailer Capital (K_r)} \]

\[ 1 - F(x) \]
\[ w_1 \]
\[ x^* \]
\[ \text{Order Quantity} \]

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2. Only a bank loan:

$$\bar{F}(x_t) = w_2; \quad \bar{F}(\theta_{tc}) = w_1 w_2 = (1 - d_{tc}).$$
The Retailer’s Response (Fixing Discount Price $w_1$)

1. No external financing:
   \[ \tilde{F}(x_1) = w_1; \]
   \[ x_2 = 0. \]

2. Only a bank loan:
   \[ \tilde{F}(x_1) = \frac{w_1}{1 - (1 - \alpha)g(\theta_{rb})}; \]
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- Solve for $w_1$ and $w_2$
The Supplier’s Problem (with Sufficient Capital)

- Solve for $\theta_{rb}$ and $\theta_{tc}$
The Supplier’s Problem (with Sufficient Capital)

- Solve for $\theta_{rb}$ and $\theta_{tc}$

\[
\max_{\theta_{rb}, \theta_{tc}, x_t} \int_{0}^{\theta_{tc}} \bar{F}(\xi) d\xi - cx_t - (1 - \alpha)[\delta(0, \theta_{rb}) + \delta(\theta_{rb}, \theta_{tc})];
\]
\[
\text{s.t.} \quad (\theta_{tc} + C(\theta_{rb}; K_r)) \bar{F}(\theta_{tc}) - x_t \bar{F}(x_t) = 0;
\]
\[
x_t \geq \theta_{tc} \geq \theta_{rb} \geq 0,
\]

where $\delta(a, b) = \int_{a}^{b} (\xi - a) dF(\xi)$, and $C(\theta_{rb}; K_r) = \frac{K_r + \int_{0}^{\theta_{rb}} \bar{F}_d(\xi; \alpha) d\xi}{\bar{F}_d(\theta_{rb}; \alpha)} - \theta_{rb}$. 
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A special case: $\theta_{rb} = \theta_{tc}$, NO trade credit is offered.
The Advantage of Trade Credit

\[ c = 0.5, \alpha = 0.5, \xi \sim \text{Unif}[0, 1] \]
The Advantage of Trade Credit

\[ c = 0.5, \quad \alpha = 0.5, \quad \xi \sim \text{Unif}[0, 1] \]
The Advantage of Trade Credit

Without Trade Credit | With Trade Credit
\[ \text{double marginalization} \]

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Without Trade Credit

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double marginalization

inefficient capital utilization
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Without Trade Credit

- double marginalization
- inefficient capital utilization

With Trade Credit

- operational and financial risks are shared
- the supplier's capital is used
- a poor retailer hurts the supplier
- the supplier can take advantage of a weak retailer

Birge and Yang (ChicagoBooth and LBS)
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**Graph:**
- **Without Trade Credit**
  - Price-Only with Sufficient Capital
  - Price-Only with A Bank Loan
- **With Trade Credit**
  - Normalized Supplier Profit vs. Normalized Retailer Capital

Mathematical Notes:
- \( c = 0.5, \alpha = 0.5, \xi \sim \text{Unif}[0, 1] \)
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The Optimal Trade Credit Terms

\[ \max_{\theta_{rb}, \theta_{tc}, x_t} \int_{0}^{\theta_{tc}} \bar{F}(\xi) d\xi - cx_t - (1 - \alpha)[\delta(0, \theta_{rb}) + \delta(\theta_{rb}, \theta_{tc})]; \]

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operational profits costs of financial distress

Without distress cost \((\alpha = 1)\), net terms \((w_1 = w_2)\) are optimal. When external financing is needed, trade credit should always be used. In general...

Birge and Yang (ChicagoBooth and LBS)
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\frac{\partial \pi_s}{\partial \theta_{rb}} = -c \frac{\partial x_t}{\partial \theta_{rb}} + (1 - \alpha)\left[\bar{F}(\theta_{rb})(1 - g(\theta_{rb})) - \bar{F}(\theta_{tc})\right];
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Inventory Financing Portfolio

How Is Inventory Financed?

Birge and Yang (Chicago Booth and LBS)

The Risk-Sharing Role of Trade Credit in Supply Chains

Wilfred Laurier (Nov. 2012)
How Is Inventory Financed?

Inventory Financing Portfolio

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Inventory Financing Portfolio

MR or MC

Order Quantity

Cash

Trade Credit

Bank Loan

w1

w2

w

w1,2

x_w*

x_t

High Financing Need vs. Low Financing Need

Birge and Yang (ChicagoBooth and LBS)

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High Financing Need vs. Low Financing Need
### How Is Inventory Financed?

#### Q4 COGS and Financing Need

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<tbody>
<tr>
<td>Q4 COGS/Annual COGS</td>
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<tr>
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<td>32.9%</td>
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</table>

#### Items as a Fraction of Assets (Q3)

<table>
<thead>
<tr>
<th></th>
<th>Inventory</th>
<th>Cash &amp; Eq</th>
<th>Receivable</th>
<th>Payable</th>
<th>Current Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4 − Q3</td>
<td>-6.7%</td>
<td>3.4%</td>
<td>0.0%</td>
<td>-2.7%</td>
<td>0.0%</td>
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*Source: Birge and Yang (Chicago Booth and LBS)*
### Q4 COGS and Financing Need

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<td>Items as a Fraction of Assets (Q3)</td>
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<td></td>
<td>25.9%</td>
</tr>
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</table>

#### Items as a Fraction of Assets (Q3)

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>40.3%</th>
<th>Low</th>
<th>29.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory</td>
<td>3.1%</td>
<td>3.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash &amp; Eq</td>
<td>3.2%</td>
<td>6.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receivable</td>
<td>17.3%</td>
<td>15.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payable</td>
<td>1.8%</td>
<td>2.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ct. Debt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## How Is Inventory Financed?

### Q4 COGS and Financing Need

<table>
<thead>
<tr>
<th></th>
<th>High Q4 COGS</th>
<th>Low Q4 COGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4 COGS/Annual COGS</td>
<td>32.9%</td>
<td>25.9%</td>
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</table>

### Items as a Fraction of Assets (Q3)

<table>
<thead>
<tr>
<th>Item</th>
<th>High (%)</th>
<th>Low (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory</td>
<td>40.3%</td>
<td>29.0%</td>
</tr>
<tr>
<td>Cash &amp; Eq</td>
<td>3.1%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Receivable</td>
<td>3.2%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Payable</td>
<td>17.3%</td>
<td>15.2%</td>
</tr>
<tr>
<td>Ct. Debt</td>
<td>1.8%</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

### Changes (Q4 – Q3)

<table>
<thead>
<tr>
<th>Change</th>
<th>High (%)</th>
<th>Low (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔInventory</td>
<td>-6.7%</td>
<td>-0.6%</td>
</tr>
<tr>
<td>ΔCash &amp; Eq</td>
<td>3.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td>ΔReceivable</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>ΔPayable</td>
<td>-2.7%</td>
<td>-0.7%</td>
</tr>
<tr>
<td>ΔCt. Debt</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Regressions

\[ \Delta \text{Payable}^i = \alpha^i_{pay} + \beta^i_{inv, pay} \Delta \text{INV}^i + \epsilon; \]
\[ \Delta \text{Ct. Debt}^i = \alpha^i_{debt} + \beta^i_{inv, debt} \Delta \text{INV}^i + \epsilon, \]

where \( i = H, L. \)
Regressions

$$\Delta \text{Payable}^i = \alpha_{pay}^i + \beta_{inv,pay}^i \Delta \text{INV}^i + \epsilon;$$

$$\Delta \text{Ct. Debt}^i = \alpha_{debt}^i + \beta_{inv,debt}^i \Delta \text{INV}^i + \epsilon,$$

where $i = H, L$.

Hypotheses

$$\beta_{inv,pay}^H > \beta_{inv,pay}^L > 0;$$

$$\beta_{inv,debt}^H > \beta_{inv,debt}^L = 0.$$
### Panel A: ΔPayable Regression

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔInventory</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.02)*</td>
<td>(0.03)*</td>
<td>(0.02)*</td>
<td>(0.03)*</td>
</tr>
<tr>
<td>ΔReceivable</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>0.25</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCash &amp; Eq.</td>
<td>0.21</td>
<td>0.09</td>
<td>0.22</td>
<td>0.09</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.40</td>
<td>0.16</td>
<td>0.40</td>
<td>0.19</td>
</tr>
</tbody>
</table>
### Panel A: ΔPayable Regression

<table>
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<tr>
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<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔInventory</td>
<td>0.62</td>
<td>0.61</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
</tr>
<tr>
<td>ΔReceivable</td>
<td>0.19</td>
<td>0.25</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.06)*</td>
<td>(0.06)*</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
</tr>
<tr>
<td>ΔCash &amp; Eq.</td>
<td>0.21</td>
<td>0.44</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
<td>(0.02)*</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.40</td>
<td>0.40</td>
<td>0.44</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>0.16</td>
<td>0.19</td>
<td>0.17</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*Note: All values are statistically significant at the 10% level.*
Panel A: ΔPayable Regression

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔInventory (Std. Error)</td>
<td>H: 0.62 (0.02)*</td>
<td>L: 0.37 (0.03)*</td>
<td>H: 0.61 (0.02)*</td>
<td>L: 0.36 (0.03)*</td>
</tr>
<tr>
<td></td>
<td>H: 0.63 (0.02)*</td>
<td>L: 0.39 (0.03)*</td>
<td>H: 0.63 (0.02)*</td>
<td>L: 0.37 (0.03)*</td>
</tr>
<tr>
<td>ΔReceivable (Std. Error)</td>
<td>H: 0.19 (0.06)*</td>
<td>L: 0.19 (0.04)*</td>
<td>H: 0.21 (0.02)*</td>
<td>L: 0.09 (0.03)*</td>
</tr>
<tr>
<td></td>
<td>H: 0.25 (0.06)*</td>
<td>L: 0.20 (0.03)*</td>
<td>H: 0.22 (0.02)*</td>
<td>L: 0.09 (0.03)*</td>
</tr>
<tr>
<td>ΑΔCash &amp; Eq. (Std. Error)</td>
<td>H: 0.21 (0.02)*</td>
<td>L: 0.09 (0.03)*</td>
<td>H: 0.22 (0.02)*</td>
<td>L: 0.09 (0.03)*</td>
</tr>
<tr>
<td></td>
<td>H: 0.44 (0.02)*</td>
<td>L: 0.17 (0.03)*</td>
<td>H: 0.45 (0.02)*</td>
<td>L: 0.19 (0.03)*</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>H: 0.40</td>
<td>L: 0.16</td>
<td>H: 0.40</td>
<td>L: 0.19</td>
</tr>
</tbody>
</table>

Figure: inventory financing portfolio with high financing need

Figure: inventory financing portfolio with low financing need
### How Is Inventory Financed?

#### Panel B: ΔCt. Debt Regression

<table>
<thead>
<tr>
<th></th>
<th>H</th>
<th>L</th>
<th>H</th>
<th>L</th>
<th>H</th>
<th>L</th>
<th>H</th>
<th>L</th>
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</thead>
<tbody>
<tr>
<td>ΔInventory</td>
<td>0.35</td>
<td>0.12</td>
<td>0.34</td>
<td>0.10</td>
<td>0.36</td>
<td>0.04</td>
<td>0.35</td>
<td>0.03</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)</td>
<td>(0.04)*</td>
<td>(0.06)</td>
</tr>
<tr>
<td>ΔReceivable</td>
<td>0.33</td>
<td>0.20</td>
<td>0.36</td>
<td>0.19</td>
<td>0.10</td>
<td>-0.40</td>
<td>0.11</td>
<td>-0.40</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.11)*</td>
<td>(0.08)*</td>
<td>(0.11)*</td>
<td>(0.08)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
</tr>
<tr>
<td>ΔCash &amp; Eq.</td>
<td></td>
<td></td>
<td>0.07</td>
<td>0.00</td>
<td>0.08</td>
<td>0.01</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>(Std. Error)</td>
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<td></td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.07</td>
<td>0.00</td>
<td>0.08</td>
<td>0.01</td>
<td>0.08</td>
<td>0.04</td>
<td>0.09</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**Figure:** inventory financing portfolio with high financing need  
**Figure:** inventory financing portfolio with low financing need
### Panel B: ∆Ct. Debt Regression

<table>
<thead>
<tr>
<th></th>
<th>I</th>
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<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>∆Inventory</td>
<td>0.35</td>
<td>0.12</td>
<td>0.34</td>
<td>0.10</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
</tr>
<tr>
<td>∆Receivable</td>
<td>0.33</td>
<td>0.20</td>
<td>0.36</td>
<td>0.19</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.11)*</td>
<td>(0.08)*</td>
<td>(0.11)*</td>
<td>(0.08)*</td>
</tr>
<tr>
<td>∆Cash &amp; Eq.</td>
<td>0.10</td>
<td>-0.40</td>
<td>0.11</td>
<td>-0.40</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
<td>(0.04)*</td>
<td>(0.06)*</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.07</td>
<td>0.00</td>
<td>0.08</td>
<td>0.01</td>
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<tr>
<td></td>
<td>0.08</td>
<td>0.04</td>
<td>0.09</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**Figure:** inventory financing portfolio with high financing need

**Figure:** inventory financing portfolio with low financing need
## How Is Inventory Financed?

### Panel B: $\Delta C_t$ Debt Regression

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta$Inventory</td>
<td>H: 0.35 (0.04)*</td>
<td>L: 0.12 (0.06)*</td>
<td>H: 0.34 (0.04)*</td>
<td>L: 0.10 (0.06)*</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td></td>
<td></td>
<td>(0.04)*</td>
<td></td>
</tr>
<tr>
<td>$\Delta$Receivable</td>
<td>H: 0.33 (0.11)*</td>
<td>L: 0.20 (0.08)*</td>
<td>H: 0.36 (0.04)*</td>
<td>L: 0.04 (0.06)*</td>
</tr>
<tr>
<td>(Std. Error)</td>
<td></td>
<td></td>
<td>(0.11)*</td>
<td></td>
</tr>
<tr>
<td>$\Delta$Cash &amp; Eq.</td>
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<td>L: -0.40 (0.06)*</td>
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<tr>
<td>(Std. Error)</td>
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<td></td>
<td>(0.04)*</td>
<td></td>
</tr>
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<td>0.07</td>
<td>0.00</td>
<td>0.08</td>
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</tbody>
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### Figure: inventory financing portfolio with high financing need

### Figure: inventory financing portfolio with low financing need
## How Is Inventory Financed?

### Panel B: ΔCt. Debt Regression

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<td>0.35</td>
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<td>0.08</td>
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</tr>
</tbody>
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### Figure: inventory financing portfolio with high financing need

### Figure: inventory financing portfolio with low financing need
Extension: Roles for Multiple Creditors and Priority Rules.

- Focus: Multiple Creditors and Priority Rules;
Extension: Roles for Multiple Creditors and Priority Rules...

- Focus: Multiple Creditors and Priority Rules;
- What is priority?
Focus: Multiple Creditors and Priority Rules;

What is priority?

- the order in which claims (bank debts, trade credit, etc.) are paid in bankruptcy.
Extension: Roles for Multiple Creditors and Priority Rules.

- **Focus:** Multiple Creditors and Priority Rules;
- **What is priority?**
  - the order in which claims (bank debts, trade credit, etc.) are paid in bankruptcy.
- **What are we interested in?**
Extension: Roles for Multiple Creditors and Priority Rules...

- **Focus:** Multiple Creditors and Priority Rules;

- **What is priority?**
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- **What are we interested in?**
  - Priority rules related to trade credit;
Extension: Roles for Multiple Creditors and Priority Rules.

- **Focus:** Multiple Creditors and Priority Rules;

- **What is priority?**
  - the order in which claims (bank debts, trade credit, etc.) are paid in bankruptcy.

- **What are we interested in?**
  - Priority rules related to trade credit;
  - The influence of priorities on trade credit usage and chain performance;
Extension: Roles for Multiple Creditors and Priority Rules...
Priority Rules

- General Case:
Priority Rules

- General Case:
  - Pre-petition: general unsecured claim;
Priority Rules

- General Case:
  - Pre-petition: general unsecured claim;
  - Post-petition: administrative priority.
Priority Rules

- **General Case:**
  - Pre-petition: general unsecured claim;
  - Post-petition: administrative priority.

- **Trade Creditors’ Reclamation Rights:**
  - Uniform Commercial Code (U.C.C.) § 2-702: reclamation of goods or value within 10 days;
  - Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA) § 546(c): reclamation of goods or value within 45 days before bankruptcy;
  - Chapter 11 Critical Vendor Motion: reclamation within 90 days;
  - BAPCPA § 503(b)(9): administrative priority claims on goods sold up to 20 days before bankruptcy;
Priority Rules

- **General Case:**
  - Pre-petition: general unsecured claim;
  - Post-petition: administrative priority.

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  - Chapter 11 Critical Vendor Motion: reclamation within 90 days;
  - BAPCPA §503(b)(9): administrative priority claims on goods sold up to 20 days before bankruptcy;

- **How Do Judges Rule?**
Notations and Assumptions

- A bank loan with market value $B$ and face value $L_b$
Notations and Assumptions

- A bank loan with market value $B$ and face value $L_b$
- Trade credit with wholesale price $w$ and line of trade credit $\bar{L}_s$
Notations and Assumptions

- A bank loan with market value $B$ and face value $L_b$
- Trade credit with wholesale price $w$ and line of trade credit $\bar{L_s}$
- Total liabilities: $L_t = L_b + L_s$
Notations and Assumptions

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- Trade credit with wholesale price $w$ and line of trade credit $\bar{L}_s$
- Total liabilities: $L_t = L_b + L_s$
- Default thresholds: $\theta_b$ and $\theta_s$
Notations and Assumptions

- A bank loan with market value $B$ and face value $L_b$
- Trade credit with wholesale price $w$ and line of trade credit $\bar{L}_s$
- Total liabilities: $L_t = L_b + L_s$
- Default thresholds: $\theta_b$ and $\theta_s$
- Allocation rule: $l_b(y)$ and $l_s(y)$ ($y$ is the total value)
  - only depends on total payoff $y$. 

No distress costs; The bank loan market is perfectly competitive:

$$B = \int_{\theta_b}^{\theta_b} l_b(y) dF(y) + L_b \bar{F}(L_b)$$

Birge and Yang (ChicagoBooth and LBS)
The Risk-Sharing Role of Trade Credit in Supply Chain

Wilfred Laurier (Nov. 2012) 24 / 41
Notations and Assumptions

- A bank loan with market value $B$ and face value $L_b$
- Trade credit with wholesale price $w$ and line of trade credit $\bar{L}_s$
- Total liabilities: $L_t = L_b + L_s$
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- No distress costs;
- The bank loan market is perfectly competitive:
  \[
  B = \int_0^{\theta_b} l_b(y) dF(y) + L_b \bar{F}(L_b)
  \]
Notations and Assumptions

- A bank loan with market value $B$ and face value $L_b$
- Trade credit with wholesale price $w$ and line of trade credit $\bar{L}_s$
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\[\text{Bank} \quad \text{Supplier} \quad \text{Retailer}\]
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How Is Inventory Financed?

The Model

- The retailer decides whether to invest in the generic project.
- The supplier proposes a contract; the retailer places an order.
- Time
- The order is delivered.
- The retailer uses trade credit or bank loan to finance inventory.
- Bank loan and trade credit are paid off, or the retailer default.
- Both demand and the generic project payoff are realized.

If yes, the retailer borrows a bank loan to finance this project.
A noisy signal of the realizations of payoffs are revealed.

[Selling to the newsvendor]: one supplier with production cost $c$, one retailer with retail price $p = 1$, salvage value $s = 0$;
One type of goods, all three parties know and agree on demand distribution $\xi \sim F(y) = f(y)$, $\bar{F}(y) = 1 - F(y)$, $g(y) = y f(y) \bar{F}(y)$;
A long term (generic) project with risky payoff;
All parties are risk-neutral (or equivalent risk-neutral measure).

Birge and Yang (ChicagoBooth and LBS)
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The Model

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Fixing Wholesale Price $w$

1. Only a Bank Loan: M-M holds, $\bar{F}(x^*) = w$;
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![Graph](image)

Figure: $c = 0.4$, $\xi \sim \text{Uniform}[0, 1]$
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**Figure**: $c = 0.4$, $\xi \sim \text{Uniform}[0, 1]$
**Proposition (Trade Credit with High Priority)**

$\exists \kappa_n^{ts} \geq 0$ such that:

1. when $K < \kappa_n^{ts}$, the supplier does not offer trade credit;
2. when $K \geq \kappa_n^{ts}$, the supplier offers a line of trade credit $\bar{L}_s = F^{-1}(c/w)$, and the retailer uses only trade credit.
Proposition (Trade Credit with High Priority)

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![Graph showing the relationship between retailer capital, trade credit used, and supplier profit for different values of \( w \).](image)
**Proposition (Trade Credit with Low Priority)**

Comparing with the case when trade credit is senior, when trade credit has low priority:

1. More retailers receive trade credit;
2. $L_t^{\overline{L}_s}$ (less trade credit is offered);
3. The supplier’s profit is higher.
Comparing Different Priorities . . .

Figure: $c = 0.6$, $w = 0.8$, $\xi \sim \text{Uniform}[0, 1]$
Comparing Different Priorities

Figure: $c = 0.6, w = 0.8, \xi \sim \text{Uniform}[0, 1]$
The Optimal Trade Credit Contract

**Proposition**

When demand uncertainty is the only risk the retailer faces, if the supplier has control of the wholesale price $w$, she offers unlimited trade credit with net terms, and the retailer only uses trade credit. Priority rules become irrelevant.
Demand Risk and A Non-Demand Risk

Adding Another Risk into the Picture

The retailer decides whether to invest in the generic project.

The supplier proposes a contract; the retailer places an order.

The order is delivered.

Both demand and the generic project payoff are realized.

Time

If yes, the retailer borrows a bank loan to finance this project.

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The long-term (generic) project needs initial investment $I$;
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Both demand risk and the generic project have binary payoffs.
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<th>Investment Payoff</th>
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<td>$1/4 + \epsilon$</td>
<td>2</td>
<td>$V$</td>
</tr>
<tr>
<td>$hl$</td>
<td>$1/4 - \epsilon$</td>
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</tr>
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<td>$V$</td>
</tr>
<tr>
<td>$ll$</td>
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Examples

- $K = 0, V = 1, I = 0.4, c = 0.4, w = 0.9.$
Examples

- $K = 0$, $V = 1$, $l = 0.4$, $c = 0.4$, $w = 0.9$.
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\sigma & \text{Probability} & \xi & \text{Project} & \pi_r & \pi_s & \pi_r & \pi_s \\
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- trade credit with high priority: same as a bank loan.
Examples (Cont.)

- *It is Not My Fault!*
**Examples (Cont.)**

- *It is Not My Fault!*
  - when $I$ and $V$ are much larger than inventory risk.
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  - let $V = 1$ and $I = 0.7$;
  - without trade credit: don’t invest!
  - with junior trade credit: invest!
Example: The Sinking Boat

\[ V = 1, I = 0.8, c = 0.4, w = 0.9; \]

Trade credit with low priority:
- bad signal: no trade credit is offered, \( x = 1; \)
- good signal: offer one unit, \( x = 2; \)

Trade credit with high priority:
- the supplier offers at most one unit of trade credit; \( x = 1. \)
Example: The Sinking Boat

Generic project

Good

90%

90%

10%

10%

Bad

90%

10%

Signal

90%

10%

Realization

hh

ll

ll

hh

Inventory decision

Good

90%

10%

II

II

hh

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\end{align*}
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\text{Bad} & \quad 10\% \\
\text{Signal} & \quad 10\% \\
\text{Realization} & \quad hh \\
\end{align*}
\]
Priorities and Efficiency

**Proposition**

When the retailer has to borrow a bank loan, assigning trade credit with low priority improves the chain efficiency and the supplier’s profit, compared with the case when trade credit has high priority.

When trade credit is junior, the supplier has the option to cut off trade credit. Anticipating that, the retailer increases cash holding. When trade credit is senior, trade credit is offered only when it is riskless.
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- When trade credit is senior, trade credit is offered only when it is riskless.
Empirical Tests of Priority Effects

BAPCA Effect Hypothesis

BAPCA (2005) raised the priority of trade credit through the 20-day administrative-claim and 45-day reclamation-right periods. The result should be a decrease in retailers’ use of trade credit and an increase in their use of bank debt.

Analysis

- Model as follows:

\[ Y_t = \sum_i \left( \frac{\text{Trade Payable}}{\text{Trade Payable} + \text{Debt in Current Liability}} \right)_{it}, \]

where \( t \) represents year and \( i \) for individual firms. Test the following specification:

\[ Y_t = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 X_t + \epsilon_t, \]

where \( D_1 \) and \( D_2 \) are dummies for 1999 – 2002 and 2006 – 2008 and \( X_t \) is GDP.
### Relative Trade Credit Regression Results

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.0089)</td>
<td>(0.0080)</td>
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<tr>
<td>1999-2002</td>
<td>-0.0397*</td>
<td>-0.0215*</td>
</tr>
<tr>
<td></td>
<td>(0.0095)</td>
<td>(0.0069)</td>
</tr>
<tr>
<td>2006-2008</td>
<td>-0.0188*</td>
<td>-0.0147*</td>
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<tr>
<td>GDP Growth</td>
<td>-0.0005</td>
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<tr>
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<td>(0.0023)</td>
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<tr>
<td>Receivable</td>
<td>-2.4319*</td>
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<tr>
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<td>(0.7498)</td>
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<tr>
<td>Constant</td>
<td>0.820*</td>
<td>1.026*</td>
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<td></td>
<td>(0.0067)</td>
<td>(0.0656)</td>
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<tr>
<td>Observations</td>
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<tr>
<td>R-squared</td>
<td>0.67</td>
<td>0.85</td>
</tr>
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</table>

**Notes:**

- The standard errors are shown in the parenthesis. * represent coefficients significant at 5%.
- The reduction in trade credit is significant (4% or 1.4% according to the specification).
## Summary: Priority under Trade Credit Theories

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The Risk-Sharing Role of Trade Credit in Supply Chain Management

Wilfred Laurier (Nov. 2012)
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Source: Birge and Yang (Chicago Booth and LBS)
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## Summary: Priority under Trade Credit Theories

<table>
<thead>
<tr>
<th>Theories of Trade Credit</th>
<th>“Optimal” Priority of Trade Credit</th>
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<tr>
<td>Transaction Cost</td>
<td>Senior</td>
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<tr>
<td>Liquidation Value</td>
<td>Senior</td>
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<td>Signaling</td>
<td>Junior</td>
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<td>Bankruptcy Reorganization</td>
<td>Junior</td>
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<td>Quality Guarantee</td>
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<td><strong>Risk-Sharing</strong></td>
<td>Junior</td>
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  - *trade-off*: risk-sharing vs. financial distress;
  - *pecking order*: $\text{Cash} \succ \text{Trade Credit} \succ \text{Debt}$. 
Conclusions

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5. Trade credit with low priority benefits the supplier and chain efficiency.

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Questions?