Productivity, Supply Chains, and the Structure of Firms

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Supply chains operate as financial vehicles that can also help with coordination

Multiple suppliers as creditors can create difficulties

Correlation and reliability issues of suppliers and creditors create nonlinear effects on the value of supplier connections

Including nonlinear effects leads to a wide variety of equilibrium network configurations

New databases (e.g., Bloomberg SPLC) provide opportunities to investigate financial and operational supply chain network interactions
Outline

- Basic of trade credit interactions
- Conflict examples with multiple creditors
- Basic network configurations
- Empirical data analysis

Our data: Compustat North America quarterly financial statements for 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

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**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 2nd (Samsung): $115.93 million 1st (Hewlett-Packard): $118.80 million
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![Diagram](image)

**Figure:** Table VI in Petersen and Rajan (1994)
The “Flexibility” in Trade Credit

2/10 Net 30

Days Payable
Cumulative Distribution

Cumulative Distribution vs. Days Payable
The “Flexibility” in Trade Credit

Days Payable
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2/10 Net 30
All Firm (N = 2127)
The “Flexibility” in Trade Credit

- 2/10 Net 30
- All Firm (N = 2127)
- Cash/Sales >0.05 (N = 675)
## Flexibility within a Subcategory

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<th>Subcategory in Retail (North America Industry Classification System)</th>
<th>Num. of firm-years</th>
<th>Days Payable 25%</th>
<th>Days Payable 50%</th>
<th>Days Payable 75%</th>
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<tbody>
<tr>
<td>All retailers</td>
<td>2127</td>
<td>27.8</td>
<td>41.1</td>
<td>58.8</td>
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<tr>
<td>Motor vehicle and parts dealers (441)</td>
<td>183</td>
<td>5.7</td>
<td>13.2</td>
<td>66.9</td>
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Birge (Chicago Booth)
Trade Credit and Inventory

- Days Inventory vs. Days Payable
- Net 30: 0 days
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Source: Birge (Chicago Booth)
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  - Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA) § 546(c): reclamation of goods or value within 45 days before bankruptcy;
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- **How Do Judges Rule?**
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The Model

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.

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

A noisy signal of the realizations of payoffs are revealed.

The retailer uses trade credit or bank loan to finance inventory.

Bank loan and trade credit are paid off, or the retailer default.
The Model

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A long term (generic) project with risky payoff;

All parties are risk-neutral (or equivalent risk-neutral measure).
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**Figure:** $c = 0.4$, $\xi \sim \text{Uniform}[0, 1]$
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**Proposition (Trade Credit with High Priority)**

\[ \exists \kappa_{ts}^n \geq 0 \text{ such that:} \]

1. when \( K < \kappa_{ts}^n \), the supplier does not offer trade credit;
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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. \( L_t^{ij} \leq L_s^* \) (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.
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.
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- 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.
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>
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<tbody>
<tr>
<td>1999-2002</td>
<td>-0.0397*</td>
<td>-0.0215*</td>
</tr>
<tr>
<td></td>
<td>(0.0089)</td>
<td>(0.0080)</td>
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<tr>
<td>2006-2008</td>
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<td>-0.0147*</td>
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<tr>
<td></td>
<td>(0.0095)</td>
<td>(0.0069)</td>
</tr>
<tr>
<td>GDP Growth</td>
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<tr>
<td></td>
<td></td>
<td>(0.0023)</td>
</tr>
<tr>
<td>Receivable</td>
<td></td>
<td>-2.4319*</td>
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<tr>
<td></td>
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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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<tr>
<td></td>
<td>(0.0067)</td>
<td>(0.0656)</td>
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<tr>
<td>Observations</td>
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<td>10</td>
</tr>
<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

<table>
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<tr>
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Connections

- With other supply chain contracts:

  - Trade credit dominates price-only contract;
  - Trade credit can achieve "super-coordination".

  - Inventory is financed by a portfolio;
  - Raises questions of the true price of over-stocking.

  - With classical static capital structure theories:
    - Trade-off: risk-sharing vs. financial distress;
    - Pecking order: Cash $\succ$ Trade Credit $\succ$ Debt.

  - Potential for conflicts implies that trade credit not favored for firms facing negatively correlated risks (and, hence, diversification may destroy value).
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1. Correlation among business interests and suppliers may create opportunities for increased risk.

2. Diversification may lead to reduced incentives for financing.

3. Independent supplier and customer interests may have value, but negative correlation may be counterindicated.

4. Nonlinear (joint firm) effects may be critical in the formation of supply chain links.

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1. Previous work: Jackson and Wolinsky (1996): Firm $i$ maximizes utility $u_i$ by creating connections $ij$ in graph $G$ (distance $d_{ij}$) where

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- Hypothesis: negative correlation yields negative $w_{i,jk}$. 

Implications for Supply Chain Structure

- Even symmetric networks with this cost structure may have widely varying equilibrium structure
- With a single parameter $\alpha$ for the correlation, a full range of degree distributions exist
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- With effort can be fully collected (so far, 8000×8000)
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- In- and out-degree follows exponential distributions
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![Graphs showing log out and in degree distributions](image-url)
Supply Chain Relationship Hypotheses

- **Performance metric: stock price**
- **First-order effects**
  - Suppliers’ and customers’ concurrent performance relates to the firm
  - Supplier momentum (one-month lag) may be related to firm performance
  - Customer momentum (following Cohen and Frazzini (2008) not related to firm performance
- **Second-order (systematic risk) effects**
  - Centrality influences firm risk and return performance
  - More central manufacturing firms have lower returns
  - More central logistics firms have higher returns
First-Order Effects

Model:

\[ r_{i,t} = \alpha + \beta_1 r_{i,t-1} + \beta_2 \sum_j w_{ij}^{in} r_{j,t-1} + \beta_3 \sum_j w_{ij}^{out} r_{j,t-1} \]

\[ + \beta_4 \sum_j w_{ij}^{in} r_{j,t} + \beta_5 \sum_j w_{ij}^{out} r_{j,t} + \epsilon_{i,t}. \]

Coefficients \( \alpha \) and \( \beta_k, k = 1, \ldots, 5 \) (estimated); \( \sum_j w_{ij}^{in} r_{j,t-1} \) - one-month supplier momentum, \( \sum_j w_{ij}^{out} r_{j,t-1} \) - one-month customer momentum, \( \sum_j w_{ij}^{in} r_{j,t} \) - concurrent supplier return, and \( \sum_j w_{ij}^{out} r_{j,t} \) - the concurrent customer return.

Use US firms in SPLC.

Monthly returns over 2010-2012.

Include common risk factors (MKT, SMB, HML, MOM).
First-Order Results

Table: Fama-Macbeth Regression of Concurrent Returns and Momentum.

<table>
<thead>
<tr>
<th></th>
<th>$\alpha$</th>
<th>$r_{i,t} - 1$</th>
<th>$\sum_j w_{ij}^{\text{in}} r_{j,t} - 1$</th>
<th>$\sum_j w_{ij}^{\text{out}} r_{j,t} - 1$</th>
<th>$\sum_j w_{ij}^{\text{in}} r_{j,t}$</th>
<th>$\sum_j w_{ij}^{\text{out}} r_{j,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave. Coef</td>
<td>-0.001</td>
<td>-0.088***</td>
<td>0.036**</td>
<td>0.024</td>
<td>0.399***</td>
<td>0.755***</td>
</tr>
<tr>
<td>(T-Stat)</td>
<td>(-0.96)</td>
<td>(-11.06)</td>
<td>(2.17)</td>
<td>(0.95)</td>
<td>(20.90)</td>
<td>(3.12)</td>
</tr>
<tr>
<td>Ave. Coef</td>
<td>0.009***</td>
<td>-0.090***</td>
<td>0.057***</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(T-Stat)</td>
<td>(10.38)</td>
<td>(-9.08)</td>
<td>(2.96)</td>
<td>(0.9)</td>
<td></td>
<td></td>
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<tr>
<td>Ave. Coef</td>
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<td>-0.047***</td>
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<td>(T-Stat)</td>
<td>(10.53)</td>
<td>(-6.96)</td>
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<td></td>
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</tr>
<tr>
<td>Ave. Coef</td>
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<td></td>
<td>0.022**</td>
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<td>(1.83)</td>
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<td>(T-Stat)</td>
<td>(11.09)</td>
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<td>Ave. Coef</td>
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<tr>
<td>Ave. Coef</td>
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<td></td>
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<td>0.619***</td>
<td>(37.25)</td>
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<td>Ave. Coef</td>
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<td></td>
<td>0.992***</td>
<td>(4.54)</td>
</tr>
<tr>
<td>(T-Stat)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Ave. Coef</td>
<td>0.004***</td>
<td></td>
<td>0.018*</td>
<td>0.625***</td>
<td>(36.44)</td>
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<td>(4.51)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ave. Coef</td>
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<td></td>
<td></td>
<td></td>
<td>1.001***</td>
<td>(4.51)</td>
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</tr>
<tr>
<td>Ave. Coef</td>
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<td></td>
<td>0.393***</td>
<td>0.744***</td>
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<td></td>
<td></td>
<td>(22.48)</td>
<td>(3.20)</td>
</tr>
</tbody>
</table>

*p-value < 10%, **p-value < 5%, ***p-value < 1%
Second-Order Effects

- **Model:**
  - Characterize centrality by eigenvector centrality and in- and out-degree centrality
  - Use average of industry if no relationship in dataset
  - Split by NAICS code (3 for manufacturing, 4 for logistics)

- Split into quintiles of centrality.
- Observe trends and significance in returns across quintiles.
## Second-Order Results: Manufacturing

**Table:** Factor Sensitivities by In-degree Centrality for Manufacturing Firms.

<table>
<thead>
<tr>
<th>N3 Portfolio</th>
<th>Alpha(%)</th>
<th>$R_{mt} - R_{ft}$</th>
<th>SMB</th>
<th>HML</th>
<th>MOM</th>
<th>Adj. $R^2$(%)</th>
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</thead>
<tbody>
<tr>
<td>1(Low)</td>
<td>0.340(0.99)</td>
<td>1.250***</td>
<td>0.327(1.17)</td>
<td>-0.366(-1.68)</td>
<td>-0.145(-1.27)</td>
<td>92.13</td>
</tr>
<tr>
<td></td>
<td>0.630*(1.81)</td>
<td>1.119***</td>
<td>(9.90)</td>
<td>(1.17)</td>
<td>(-1.68)</td>
<td>(1.27)</td>
</tr>
<tr>
<td>2</td>
<td>0.077(0.22)</td>
<td>1.220***</td>
<td>0.491(1.85)</td>
<td>-0.594**(-2.86)</td>
<td>0.025(0.23)</td>
<td>91.10</td>
</tr>
<tr>
<td></td>
<td>0.414(1.25)</td>
<td>1.085***</td>
<td>(10.07)</td>
<td>(1.85)</td>
<td>(-2.86)</td>
<td>(0.23)</td>
</tr>
<tr>
<td>3</td>
<td>0.430(1.26)</td>
<td>0.902***</td>
<td>-0.561*(-2.00)</td>
<td>-0.205(-0.94)</td>
<td>0.079(0.69)</td>
<td>86.05</td>
</tr>
<tr>
<td></td>
<td>0.175(0.50)</td>
<td>1.091***</td>
<td>(9.61)</td>
<td>(-2.00)</td>
<td>(-0.94)</td>
<td>(0.69)</td>
</tr>
<tr>
<td>4</td>
<td>0.105(0.37)</td>
<td>1.066***</td>
<td>-0.079(-0.31)</td>
<td>-0.338(-1.73)</td>
<td>0.022(0.22)</td>
<td>92.44</td>
</tr>
<tr>
<td></td>
<td>0.127(0.41)</td>
<td>1.098***</td>
<td>(10.83)</td>
<td>(-0.31)</td>
<td>(-1.73)</td>
<td>(0.22)</td>
</tr>
<tr>
<td>5(High)</td>
<td>0.053(0.16)</td>
<td>0.804***</td>
<td>-0.659***(-3.05)</td>
<td>-0.431**(-2.56)</td>
<td>0.009(0.10)</td>
<td>84.67</td>
</tr>
<tr>
<td></td>
<td>-0.170(-0.63)</td>
<td>1.006***</td>
<td>(11.52)</td>
<td>(-3.05)</td>
<td>(-2.56)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>High-Low</td>
<td>-0.287***(-2.87)</td>
<td>-0.446***</td>
<td>(11.52)</td>
<td>(-3.05)</td>
<td>(-2.56)</td>
<td>(0.10)</td>
</tr>
<tr>
<td></td>
<td>-0.800***(-8.52)</td>
<td>-0.113***</td>
<td>(-3.71)</td>
<td>(-13.10)</td>
<td>(-1.10)</td>
<td>(5.03)</td>
</tr>
</tbody>
</table>

*p-value|10%, **p-value|5%, ***p-value|1%
### Second-Order Results: Logistics

**Table:** Factor Sensitivities by In-degree Centrality for Logistics Firms.

<table>
<thead>
<tr>
<th>N4 Portfolio</th>
<th>Alpha(%)</th>
<th>$R_{mt} - R_{ft}$</th>
<th>Factor Loadings</th>
<th>Adj. $R^2$(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$SMB$</td>
<td>$HML$</td>
</tr>
<tr>
<td>1 (Low)</td>
<td>0.061</td>
<td>1.072***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(9.10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.324</td>
<td>1.302***</td>
<td>-0.684</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>(-0.58)</td>
<td>(7.19)</td>
<td>(-1.53)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>2</td>
<td>0.327</td>
<td>1.078***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td>(10.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.327</td>
<td>1.153***</td>
<td>-0.875**</td>
<td>-0.065</td>
</tr>
<tr>
<td></td>
<td>(0.78)</td>
<td>(8.87)</td>
<td>(-2.72)</td>
<td>(-0.26)</td>
</tr>
<tr>
<td>3</td>
<td>0.493</td>
<td>0.973***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.01)</td>
<td>(8.59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.242</td>
<td>1.142***</td>
<td>-0.427</td>
<td>-0.092</td>
</tr>
<tr>
<td></td>
<td>(0.44)</td>
<td>(6.40)</td>
<td>(-0.97)</td>
<td>(-0.27)</td>
</tr>
<tr>
<td>4</td>
<td>0.703*</td>
<td>0.893***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.73)</td>
<td>(9.50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.741</td>
<td>0.888***</td>
<td>0.737*</td>
<td>-0.571*</td>
</tr>
<tr>
<td></td>
<td>(1.67)</td>
<td>(6.20)</td>
<td>(2.08)</td>
<td>(-2.07)</td>
</tr>
<tr>
<td>5 (High)</td>
<td>0.922**</td>
<td>0.638***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.71)</td>
<td>(8.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.878**</td>
<td>0.735***</td>
<td>-0.140</td>
<td>-0.549**</td>
</tr>
<tr>
<td></td>
<td>(2.81)</td>
<td>(7.26)</td>
<td>(-0.56)</td>
<td>(-2.81)</td>
</tr>
<tr>
<td>High-Low</td>
<td>0.861***</td>
<td>-0.434***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.60)</td>
<td>(-14.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.202***</td>
<td>-0.567***</td>
<td>0.544***</td>
<td>-0.646***</td>
</tr>
<tr>
<td></td>
<td>(8.80)</td>
<td>(-12.82)</td>
<td>(4.97)</td>
<td>(-7.57)</td>
</tr>
</tbody>
</table>

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Conclusions

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Thank you! Any questions?