Supply Chain Risks and Corporate Performance: Evidence From Demand-Supply Mismatches

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Why empirical research?

- Without facts you are just another person with an opinion
  
  **unless**
  
  you are at a level of the organization where your opinion becomes fact

- When research is limited or absent, anecdotes prevail

- Empirical research gets more attention from top management and the business press
Surveys about supply chain risks

- 70% of executives indicate that supply chain risks has increased in the past three years (McKinsey 2010)

- 68% of executives indicate that supply chain risk will increase in the next 5 years (McKinsey 2010)

- 48% of executives indicate that the frequency of supply chain risk events with negative outcomes have increased in the last three years (Deloitte 2013)

- 64% of executives claim to have supply chain risk management programs but only 55% think that these are effective (Deloitte 2013)
Obstacles to addressing risks

- Insufficient time: 47%
- Inadequate personnel: 36%
- Insufficient budget: 36%
- Not a priority: 18%
- No reason given: 14%
- Not recognized: 6%

Survey done by Harris Interactive in 2005.
Supply chain risks

• Supply chain risks causes demand-supply mismatches

  - Supply is less than demand (undersupply or disruptions)

  - Supply is greater than demand (oversupply or excess inventory)

  - Product introduction delays
Measuring performance consequences

• Shareholder value

• Share price volatility – measure of risk

• Profitability – operating income, sales, and cost
Examples of supply chain disruptions

• About 1100 announcements from 1987-2007


  • Sony Sees Shortage of Playstation 2s for Holiday Season, *Wall Street Journal*, September 28, 2000

  • Recent product recalls by Toyota

  • Boeing Dreamliner delay
Examples of excess inventory

• About 850 announcements from 1990-2002


  • Intel to write down inventories of components, *Dow Jones News Service*, March 16, 1996

  • Growing inventory backlogs at car dealers in China

  • Excess inventory at Blackberry
Examples of product introduction delays

• About 435 announcements from 1987-2003


• The new product delays that cut into Boston Scientific Corp.'s (BSX) fourth quarter earnings will also hurt the first quarter, its chief financial officer said”, *The Wall Street Journal*, February 8, 2000

• Delays in introducing new phones at Nokia

• Delays in drug development at Eli Lilly and Pfizer
Consequences of supply chain risks

• Lower Revenues

• Higher costs

• Poor asset utilization

• Excess inventory, inventory write-offs, stockouts

• Higher cost of capital/borrowing

• Shareholder lawsuits

• Management and personnel turnover

• Loss of reputation and credibility, negative publicity
Sample creation

(inventory or inventories) near5 (obsolete or obsolescence or excess or excessive or glut or buildup or builds or build or building or reduce or reducing or reduced or reduces or reduction or reductions or bloated or bloating or charge or charges or charging or write$ or adjust or adjustment or adjustments or adjusts or adjusting or adjusted or liquidate or liquidates or liquidating or liquidated or loss$ or accumulate or accumulates or accumulated or accumulating or revaluate or revaluates or revaluated or revaluating or revaluation)
Stock market reaction to announcements

• Stock market efficiency
  - reacts instantly to new information
  - unbiased estimate of the value implications of the announcement

• Other factors could influence stock price on announcement day – must control for these
Methodology

• Stock market’s reaction is normally referred to as **Abnormal Return**

• Estimate abnormal returns around the time of announcement

• Abnormal returns associated with the announcement
  
  = actual return including the effect of the announcement - expected return (normal return) without the announcement

• Test for statistical significance
Method for computing abnormal returns

- On September 28, 2010, Boeing announces a disruption
- Set September 28, 2000 as day 0 in event time
- Day -1 is the previous trading day
- Day 1 is the following trading date

- Estimating normal (expected) returns
  Four factor model: \( R_{it} = a_i + B_{i1} (R_{mt} - R_{ft}) + B_{i2} \text{SMB}_{it} + B_{i3} \text{HML}_{it} + B_{i4} \text{UMD}_{it} + e_{it} \)

  \( R_{mt} - R_{ft} = \) market return less risk free rate of return (market risk premium)
  \( \text{SMB}_{it} = \) small firms minus big firms portfolio returns
  \( \text{HML}_{it} = \) value stocks minus growth stocks portfolio returns
  \( \text{UMD}_{it} = \) past one-year winners-minus-losers stock portfolio returns

- Abnormal return = actual return – expected return
Average stock returns on demand-supply mismatch announcements

<table>
<thead>
<tr>
<th>Event</th>
<th>Abnormal returns (%) Mean</th>
<th>Abnormal returns (%) Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply chain disruption</td>
<td>-7.2</td>
<td>-5.6</td>
</tr>
<tr>
<td>Excess inventory</td>
<td>-6.9</td>
<td>-5.0</td>
</tr>
<tr>
<td>Product introduction delay</td>
<td>-12.8</td>
<td>-9.0</td>
</tr>
</tbody>
</table>
% of firms with negative stock returns

- Supply Disruptions: 72.64%
- Excess Inventory: 73.19%
- Product Introduction Delays: 85.08%
Comparison with stock market reaction to other corporate events

<table>
<thead>
<tr>
<th>Operational events</th>
<th>Marketing events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in capital expenditure</td>
<td>Change in firm name</td>
</tr>
<tr>
<td>1.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Increase in R&amp;D expenditure</td>
<td>Brand leveraging</td>
</tr>
<tr>
<td>1.4%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Effective TQM implementation</td>
<td>Celebrity endorsement</td>
</tr>
<tr>
<td>0.7%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Internal corporate restructuring</td>
<td>New product introduction</td>
</tr>
<tr>
<td>1.0%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Decrease in capital expenditure</td>
<td>Affirmative action awards</td>
</tr>
<tr>
<td>-1.8%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Plant closing</td>
<td></td>
</tr>
<tr>
<td>-0.7%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information technology events</th>
<th>Financial events</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Investments</td>
<td>Stock splits</td>
</tr>
<tr>
<td>1.0%</td>
<td>3.3%</td>
</tr>
<tr>
<td>IT problems</td>
<td>Open market share repurchase</td>
</tr>
<tr>
<td>-1.7%</td>
<td>3.5%</td>
</tr>
<tr>
<td></td>
<td>Proxy contest</td>
</tr>
<tr>
<td></td>
<td>4.2%</td>
</tr>
<tr>
<td></td>
<td>Increasing financial leverage</td>
</tr>
<tr>
<td></td>
<td>7.6%</td>
</tr>
<tr>
<td></td>
<td>Decreasing financial leverage</td>
</tr>
<tr>
<td></td>
<td>-5.4%</td>
</tr>
<tr>
<td></td>
<td>Seasoned equity offerings</td>
</tr>
<tr>
<td></td>
<td>-3.0%</td>
</tr>
</tbody>
</table>
# Drivers of stock market reaction

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Supply chain disruption</th>
<th>Excess Inventory</th>
<th>Product introduction delays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>POS</td>
<td>POS</td>
<td>POS</td>
</tr>
<tr>
<td>Growth potential</td>
<td>NEG</td>
<td>NEG</td>
<td>NEG</td>
</tr>
<tr>
<td>Industry competitiveness</td>
<td>NS</td>
<td>NS</td>
<td>NEG</td>
</tr>
<tr>
<td>Time</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Debt-equity ratio</td>
<td>NS</td>
<td>NEG</td>
<td></td>
</tr>
<tr>
<td>Business diversification</td>
<td>NS</td>
<td></td>
<td>POS</td>
</tr>
<tr>
<td>Geographic diversification</td>
<td>NEG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical relatedness</td>
<td>POS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational slack</td>
<td>POS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess Inventory at customer</td>
<td></td>
<td>NEG</td>
<td></td>
</tr>
</tbody>
</table>
Estimating profitability impacts

• Return on assets (ROA)
  ▪ Operating income normalized by total assets

• Sales over assets (SOA)

• Return on Sales (ROS)
  ▪ Operating income normalized by sales
Measurement period for profitability changes

- Boeing announces a disruption on September 28, 2010

- Set 2010 as year 0 in event time

  ![Diagram showing the time period for measurement](image)

  - Match on base year
    - Performance (ROA, SOA, ROS)
    - Size
    - Industry
Change in return on sales (ROA) from year -2 to year 1

Return on assets (%)

<table>
<thead>
<tr>
<th>Disruptions</th>
<th>Excess inventory</th>
<th>Product introduction delays</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.2</td>
<td>12.9</td>
<td>11.8</td>
</tr>
<tr>
<td>8.1</td>
<td>9.6</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Disruptions, Excess inventory, Product introduction delays

Expected ROA, Actual ROA
### Change in return on sales (ROS) from year -2 to year 1

<table>
<thead>
<tr>
<th></th>
<th>Expected ROS</th>
<th>Actual ROS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disruptions</td>
<td>10.1</td>
<td>6.6</td>
</tr>
<tr>
<td>Excess inventory</td>
<td>11.0</td>
<td>8.4</td>
</tr>
<tr>
<td>Product</td>
<td>10.8</td>
<td>8.1</td>
</tr>
<tr>
<td>introduction</td>
<td>delays</td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**

- **Return on sales (%)**
  - **Disruptions:**
    - Expected ROS: 10.1%
    - Actual ROS: 6.6%
  - **Excess inventory:**
    - Expected ROS: 11.0%
    - Actual ROS: 8.4%
  - **Product introduction delays:**
    - Expected ROS: 10.8%
    - Actual ROS: 8.1%
Change in sales over assets (SOA) - year -2 to year 1

<table>
<thead>
<tr>
<th></th>
<th>Disruptions</th>
<th>Excess inventory</th>
<th>Product introduction delays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected SOA</td>
<td>115.3</td>
<td>115.9</td>
<td>105.3</td>
</tr>
<tr>
<td>Actual SOA</td>
<td>108.9</td>
<td>109.2</td>
<td>92.8</td>
</tr>
</tbody>
</table>

Sales over assets (%)

Disruptions

Excess inventory

Product introduction delays

Expected SOA

Actual SOA
Measurement period for share price volatility changes

- Boeing announces a disruption on September 28, 2010
- Set September 28, 2010 as day 0 in event time

Factors used to create benchmarks of firms
- Prior Volatility
- Size
- Industry
Volatility Changes from year -2 to year 1

Disruptions | Excess inventory | Product introduction delays

Unadjusted: 21.3% | 29.1% | 25.6%
Adjusted: 5.4% | 10.5% | 10.2%
Drivers of changes in stock price volatility

- Demand Supply mismatch
- Information asymmetry
- Information quality
- Financial leverage
- Operating leverage
- Abnormal changes in volatility

The diagram illustrates the relationships between different factors that drive changes in stock price volatility.
Summary

• Demand-supply mismatches cause significant destruction in corporate performance

• It does not matter who or what caused the mismatch—you still pay

• Smaller firms suffer more from mismatches

• Firms do not quickly recover from mismatches
Why enough attention is not paid to supply chain risks?

• Consequences are not known
• Low frequency events
• Resource shortages
• Requires cross-functional effort
• Short tenure of managers
• You don’t get credit for fixing problems that never happened
• You have not experienced one
Are firms more prone to supply chain risks today?

• Globalization of supply chains
• Increased reliance on outsourcing and partnerships
• Single sourcing
• Little slack in the supply chain
• Competition
Summary

• Can you afford the occurrence of a major supply chain risk event?

• Supply chain risk management is like buying insurance - Insurance is often most worth having when it seems least necessary.

• Insurance is often hard to cost justify.

• What is the easiest way to create shareholder value or make money?  Stop losing it!
Future research issues

• Understand how upstream and downstream supply chain partners get affected by supply/demand mismatches

• Demand/supply mismatches and cost of capital

• What is the effectiveness of various strategies in dealing with supply chain risks?

• Trade-off between supply chain efficiency and risk.
A process for managing supply chain risks

- Identify the primary sources of supply chain risks.
- Identify the causes of supply chain risks
- Estimate the likelihood (probability, frequency, or chances) of the risk occurring.
- Estimate the financial consequences (impact) of risks.
- Prioritize risks based on likelihood and financial impact.
- Identify strategies and actions to mitigate the frequency and/or financial consequences of supply chain risks.
- Review the risk management process and continuously improve the process.
Strategies for managing supply chain risks

- Contingency planning
  - Analyze what could potentially go wrong
  - Identify and analyze possible alternatives
  - Develop plans – what to do, when, how, and who
  - Assign responsibility and give authority
  - Monitor the situation
  - Execute the plan as needed
Strategies for managing supply chain risks

- Redundancy
  - Extra inventory
  - Extra capacity
  - Backup systems
  - Multiple suppliers
  - Multiple sites
  - Dedicated resource to products, processes
Strategies for managing supply chain risks

- Reduce the frequency (probability) of disruptions
  - Better forecasting
  - Better planning
  - Communicate, collaborate, and share
  - Build trust in the network

- Develop ability to predict disruptions (business intelligence)
  - Select, define, track key performance indicators
  - Analyze disruptions to develop leading indicators
  - Track leading indicators
  - Need visibility
Strategies for managing supply chain risks

- Elapsed time between the occurrence and detection of disruptions
  - Aim for zero elapsed time
  - Real time visibility of the extended supply chain

- Time it takes to resolve disruptions
  - Quick resolution, prevent escalation and worsening
  - A process for dealing/responding to disruptions
  - Developing capabilities to react and respond
Strategies for managing supply chain risks

- Know your suppliers
  - Two-way communication - build trust and relationship with critical suppliers
  - Set up a financial rating system – profitability, cash flows, ownership structure, debt structure
  - Set up an early warning system – quality, capacity, delivery issues, financial issues
- Know your suppliers’ suppliers
- Interdependencies of your suppliers – same customers, same industries, same shareholders
Strategies for managing supply chain risks

- Know your customers
  - Two-way communication - build trust and relationship with key customers
  - Set up a financial rating system – profitability, cash flows, ownership structure, debt structure
  - Set up an early warning system – payment timing, inventory
  - Concentration of customer base
  - Know your customers’ customers
  - Other suppliers to your customers
Strategies for managing supply chain risks

- **Visibility**
  - Aware of what is happening in supply chains
  - Select key leading indicators of supply chain
  - Monitor these indicators using appropriate benchmark
  - Communicate deviations to appropriate levels

- **Collaborate and cooperate with your supply chain partners**
  - Develop trust among supply chain partners
  - Show that you are willing to collaborate
  - Agree upfront on how to share the benefits
  - Share information, joint decision making/problem solving
Strategies for managing supply chain risks

- Improve the accuracy of forecasts
  - Long-term forecasts are less accurate than short-term
  - Aggregate forecasts are easier than disaggregate
  - Collect data from your supply chain partners
  - Question the assumptions that go into building a forecast

- Reduce mean and variance of lead times
  - Remove non-value added steps and activities
  - Improve the reliability and robustness of processes
  - Consider lead time issues in planning and forecasting
Strategies for managing supply chain risks

- **Flexibility**
  - Product design
    - standardization
    - modularity
    - parts commonality
  - Manufacturing
    - flexible technology and capacity
    - committed and uncommitted capacity
    - standard processes
    - cross-training
  - Sourcing
    - flexible contracts
    - multiple sourcing
    - supplier capabilities
    - spot markets
Strategies for managing supply chain risks

- Turbo charge your imagination
- Build Scenarios
- Probabilities
- Face reality
- Quick response
- Share the bad news