Uncertainty, Technology, and Market Effects on Production, Inventory, and Financial Decisions

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Outline

• Views from OM and Finance
• Effect of financial considerations on production, capacity, and inventory decisions
• Examples in two and multiple stages
• Conclusions
Contrasting Views

• Typical operations management view
  – Models to determine best choices: prescriptive
  – Focus on capacity, production, and inventory
  – No concern for financing
  – No consideration of agent interactions
  – Little empirical verification

• Typical finance view
  – Results in perfect markets
  – Models for choice of financing: often descriptive
    (capturing what actually happens, little on ops)
  – Consideration of agent interactions and motivations
  – Emphasis on empirical verification
Questions

• Are the two views in any way consistent?
  – Do operations managers really need prescriptive models?
  – Can financing be independent of operations?
  – Should we let actual practice be the model for optimal decisions?

• How can we gain insights from both views?
Should We Have an Integrated Corporate Planning System?

- **Issues**
  - Independent functional planning
  - Without firm valuation
  - Without contingent plan

- **Traditional Planning Systems**
  - Production Planning
  - Financial Planning
  - Marketing Planning
Factors to Consider

- Increasing interconnections and complexity (e.g., outsourcing, consolidation, specialization)
- Decreasing centralized control (e.g., decreasing vertical integration)
- Decreasing slack, time-inventory, and supplier buffers (e.g., JIT)
- Increasing value of responsiveness and customization
- Increasing risk of moral hazard and adverse selection (contract limitations)
Single Stage Model (XX/JRB)

Basic Issues

- Financing affects production decisions
- Traditional analyses ignore interactions

Objectives

- Analyze the interactive mechanism between operational and financial decisions
- Identify situations where financial effects most significant
Notation: News Vendor Framework

\( \hat{c} \) : production cost  \quad \hat{p} : \) selling price

\( \hat{v} \) : salvage value (\( \hat{v} < \hat{c} \))  \quad \hat{g} : \) lost of goodwill penalty cost

\( f(s) \) : risk neutral equivalent density distribution function

\( E[\text{Sales}] : \quad S(x) = x[1 - F(x)] + \int_0^x q f(q) dx \)

\( E[\text{left over inventory}] : \quad I(x) = x - S(x) \)

\( E[\text{unsatisfied demand}] : \quad L(x) = \mu - S(x) \)

Firm’s expected profit:

\[
\pi (x) = \hat{p} S(x) + \hat{v} I(x) - \hat{g} L(x) - \hat{c} x
\]

\[
= \left( \hat{p} - \hat{v} + \hat{g} \right) S(x) - \left( \hat{c} - \hat{v} \right) x - \hat{g} \mu
\]

\[
\equiv p S(x) - c x - \hat{g} \mu
\]

Normalize salvage value and penalty cost to 0
**Firm with Financial Constraints**

News vendor model with internal capital $k$

$$\max \quad px[1 - F(x)] + p \int_{x}^{\infty} qf(q)ds - cx(1 + rf)$$

$$s.t. \quad 0 \leq cx \leq k$$

**Source of Financing:**

Equity Issuing, Corporate Bond, Venture Capital, Bank Loan

Bank Loan $\rightarrow$ Interest Rate?
Payoff to debt holders

\[ Y_D = \begin{cases} 
D(1+r) & \text{if } q \geq q^b \\
pq & \text{if } q < q^b 
\end{cases} \]

where \( q^b \equiv L/p \) bankruptcy demand point

D: price of debt \quad L: face value of debt

Debt pricing under risk-neutral equivalent demand distribution

\[
D(1 + r_f) = L[1 - F(L/p)] + p \int_0^{L/p} q f(q) dq
\]

Debt pricing equation
Financial Market Imperfections

- Modigliani-Miller (MM): firm’s investment and financial decisions can be made separately.

- Market Imperfections
  - Corporate taxes
  - Financial distress cost
  - Agency conflicts
  - Asymmetric information
  - Transaction costs

- Corporate Finance Theories
  - Tradeoff Theory: Tax Advantage v. Financial Distress
  - Agency Theory/Pecking Order Theory: Signals to Market
  - Asymmetric Information
Joint Decision Making in an Imperfect Market
Interactive Effects between Production and Financial Decisions

- Separate operational and financial decision making is sub-optimal
- Production decision is negatively related with the production cost
- Debt decision is positively related with the production cost
- Optimal production decision is a decreasing function of financial leverage
The Effects of Decision Misspecification

Key Observations:

- Firm’s value is a convex function of financial leverage
- The effect of over-leverage is more severe than under-leverage
- Low-margin companies especially exposed to misspecifying decisions
- The effect of production decision misspecification is more severe
Production Margin and Capital Structure

Tradeoff-Theory

An lower profit margin results in higher leverage (Fama & French 2002)

Model results

Leverage ratio is convex and U-shaped in production cost

Empirical Results

For very high margin, leverage ratio appear to increase (Value Line 2004)
Multistage Equity Value

- Equity valuation by Integrated Model, Fixed Interest Rate, Discount Dividend methods
  - Performance: $V_{ICP} \geq V_{FI} > V_{DDV}$
  - Decreasing in production cost, volatility
  - Increasing in bankruptcy recovery, terminal value multiple
  - Wider gaps for high margins, large volatility, recovery, terminal value

- Integrated corporate planning
  - production + financial
- Fixed interest method
  - risk free interest rate
- Discount Dividend Method
  - mean value of uncertainty
Multistage Compared to Single Stage

Observations:

- Equity value increases with multiple stages
- Leverage decreases with multiple stages
- Bigger gaps for higher margins (low costs)
Conclusions

Results:

- Integration appears important in imperfect markets, esp. for low-margin producers
- Tradeoff approach here produces decreasing leverage in margin that may then increase for very high margins
- Some empirical support for predictions
- Longer term views lead to lower leverage

Extensions: effects of agency, supplier relations

- Additional empirical support for conclusions?