Chapter 4
Supply Contracts

4.1 Introduction
- Significant level of outsourcing
- Many leading brand OEMs outsource complete manufacturing and design of their products
- More outsourcing has meant
  - Search for lower cost manufacturers
  - Development of design and manufacturing expertise by suppliers
- Procurement function in OEMs becomes very important
- OEMs have to get into contracts with suppliers
  - For both strategic and non-strategic components

4.2 Strategic Components
Supply Contract can include the following:
- Pricing and volume discounts.
- Minimum and maximum purchase quantities.
- Delivery lead times.
- Product or material quality.
- Product return policies.

2-Stage Sequential Supply Chain
- A buyer and a supplier.
- Buyer’s activities:
  - generating a forecast
  - determining how many units to order from the supplier
  - placing an order to the supplier so as to optimize his own profit
- Supplier’s activities:
  - reacting to the order placed by the buyer.
  - Make-To-Order (MTO) policy

Swimsuit Example
- 2 Stages:
  - a retailer who faces customer demand
  - a manufacturer who produces and sells swimsuits to the retailer.
- Retailer Information:
  - Summer season sale price of a swimsuit is $125 per unit.
  - Wholesale price paid by retailer to manufacturer is $80 per unit.
  - Salvage value after the summer season is $20 per unit.
- Manufacturer information:
  - Fixed production cost is $100,000
  - Variable production cost is $35 per unit

What Is the Optimal Order Quantity?
- Retailer marginal profit is the same as the marginal profit of the manufacturer, $45.
- Retailer’s marginal profit for selling a unit during the season, $45, is smaller than the marginal loss, $60, associated with each unit sold at the end of the season to discount stores.
- Optimal order quantity depends on marginal profit and marginal loss but not on the fixed cost.
- Retailer optimal policy is to order 12,000 units for an average profit of $470,700.
- If the retailer places this order, the manufacturer’s profit is $440,000.
Sequential Supply Chain

Risk Sharing

- In the sequential supply chain:
  - Buyer assumes all of the risk of having more inventory than sales.
  - Buyer limits his order quantity because of the huge financial risk.
  - Supplier takes no risk.
  - Supplier would like the buyer to order as much as possible.
  - Since the buyer limits his order quantity, there is a significant increase in the likelihood of out of stock.
  - If the supplier shares some of the risk with the buyer:
    - It may be profitable for buyer to order more.
    - Reducing out of stock probability.
    - Increasing profit for both the supplier and the buyer.
  - Supply contracts enable this risk sharing.

Buy-Back Contract

- Seller agrees to buy back unsold goods from the buyer for some agreed-upon price.
- Buyer has incentive to order more.
- Supplier’s risk clearly increases.
- Increase in buyer’s order quantity:
  - Decreases the likelihood of out of stock.
  - Compensates the supplier for the higher risk.

Buy-Back Contract

- Assume the manufacturer offers to buy unsold swimsuits from the retailer for $55.
- Retailer has an incentive to increase its order quantity to 14,000 units, for a profit of $513,800, while the manufacturer’s average profit increases to $471,900.
- Total average profit for the two parties: $985,700 ($513,800 + $471,900).
- Compare to sequential supply chain when total profit: $910,700 ($470,700 + $440,000).

Revenue Sharing Contract

- Buyer shares some of its revenue with the supplier in return for a discount on the wholesale price.
- Buyer transfers a portion of the revenue from each unit sold back to the supplier.
Revenue Sharing Contract Swimsuit Example

- Manufacturer agrees to decrease the wholesale price from $80 to $60
- In return, the retailer provides 15 percent of the product revenue to the manufacturer.
- Retailer has an incentive to increase his order quantity to 14,000 for a profit of $504,325
- This order increase leads to increased manufacturer’s profit of $481,375
- Supply chain total profit = $985,700 (= $504,325 + $481,375).

Other Types of Contracts

- **Quantity-Flexibility Contracts**
  - Supplier provides full refund for returned (unsold) items
  - As long as the number of returns is no larger than a certain quantity.
- **Sales Rebate Contracts**
  - Provides a direct incentive to the retailer to increase sales by means of a rebate paid by the supplier for any item sold above a certain quantity.

Global Optimization Strategy

- What is the best strategy for the entire supply chain?
- Treat both supplier and retailer as one entity
- Transfer of money between the parties is ignored

Global Optimization Swimsuit Example

- Relevant data
  - Selling price, $125
  - Salvage value, $20
  - Variable production costs, $35
  - Fixed production cost.
  - Supply chain marginal profit, 90 = 125 - 35
  - Supply chain marginal loss, 15 = 35 – 20
  - Supply chain will produce more than average demand.
  - Optimal production quantity = 16,000 units
  - Expected supply chain profit = $1,014,500.
Global Optimization and Supply Contracts

- Unbiased decision maker unrealistic
  - Requires the firm to surrender decision-making power to an unbiased decision maker
- Carefully designed supply contracts can achieve as much as global optimization
- Global optimization does not provide a mechanism to allocate supply chain profit between the partners.
- Supply contracts allocate this profit among supply chain members.
- Effective supply contracts allocate profit to each partner in a way that no partner can improve his profit by deciding to deviate from the optimal set of decisions.

Implementation Drawbacks of Supply Contracts

- **Buy-back contracts**
  - Require suppliers to have an effective reverse logistics system and may increase logistics costs.
  - Retailers have an incentive to push the products not under the buy-back contract.
- **Revenue sharing contracts**
  - Require suppliers to monitor the buyer’s revenue and thus increases administrative cost.
  - Buyers have an incentive to push competing products with higher profit margins.
  - Similar products from competing suppliers with whom the buyer has no revenue sharing agreement.

Supply Chain for Fashion Products

**Ski-Jackets**

- **Manufacturer produces ski-jackets prior to receiving distributor orders**
  - Season starts in September and ends by December.
  - Production starts 12 months before the selling season
  - Distributor places orders with the manufacturer six months later.
  - At that time, production is complete; distributor receives firms orders from retailers.
  - The distributor sales ski-jackets to retailers for $125 per unit.
  - The distributor pays the manufacturer $80 per unit.
  - For the manufacturer, we have the following information:
    - Fixed production cost = $100,000.
    - The variable production cost per unit = $55
    - Salvage value for any ski-jacket not purchased by the distributors = $20.

Profit and Loss

- **For the manufacturer**
  - Marginal profit = $25
  - Marginal loss = $60.
  - Since marginal loss is greater than marginal profit, the distributor should produce less than average demand, i.e., less than 13,000 units.
- **How much should the manufacturer produce?**
  - Manufacturer optimal policy = 12,000 units
  - Average profit = $160,400.
  - Distributor average profit = $510,300.
  - Manufacturer assumes all the risk limiting its production quantity
  - Distributor takes no risk

Make-to-Stock Ski Jackets

- **Expected Profit**
  - Expected profit increases as production quantity increases, but beyond a certain point, the profit decreases.

FIGURE 4-5: Manufacturer’s expected profit
Pay-Back Contract

- Buyer agrees to pay some agreed-upon price for any unit produced by the manufacturer but not purchased.
- Manufacturer incentive to produce more units
- Buyer’s risk clearly increases.
- Increase in production quantities has to compensate the distributor for the increase in risk.

Pay-Back Contract

Ski Jacket Example

- Assume the distributor offers to pay $18 for each unit produced by the manufacturer but not purchased.
- Manufacturer marginal loss = 55-20-18=$17
- Manufacturer marginal profit = $25.
- Manufacturer has an incentive to produce more than average demand.
- Manufacturer increases production quantity to 14,000 units
- Manufacturer profit = $180,280
- Distributor profit increases to $525,420.
  - Total profit = $705,400
- Compare to total profit in sequential supply chain = $670,000 (= $160,400 + $510,300)

Cost-Sharing Contract

- Buyer shares some of the production cost with the manufacturer, in return for a discount on the wholesale price.
- Reduces effective production cost for the manufacturer
- Incentive to produce more units

Cost-Sharing Contract

Ski-Jacket Example

- Manufacturer agrees to decrease the wholesale price from $80 to $62
- In return, distributor pays 33% of the manufacturer production cost
- Manufacturer increases production quantity to 14,000
- Manufacturer profit = $182,380
- Distributor profit = $523,320
- The supply chain total profit = $705,700
  - Same as the profit under pay-back contracts
Implementation Issues

- Cost-sharing contract requires manufacturer to share production cost information with distributor
- Agreement between the two parties:
  - Distributor purchases one or more components that the manufacturer needs.
  - Components remain on the distributor books but are shipped to the manufacturer facility for the production of the finished good.

Global Optimization

- Relevant data:
  - Selling price, $125
  - Salvage value, $20
  - Variable production costs, $55
  - Fixed production cost
- Cost that the distributor pays the manufacturer is meaningless
- Supply chain marginal profit, $70 = 125 – 55
- Supply chain marginal loss, $35 = 55 – 20
- Supply chain will produce more than average demand.
- Optimal production quantity = 14,000 units
- Expected supply chain profit = $705,700

4.4 Contracts with Asymmetric Information

- Implicit assumption so far: Buyer and supplier share the same forecast
- Inflated forecasts from buyers a reality
- How to design contracts such that the information shared is credible?
Two Possible Contracts

- Capacity Reservation Contract
  - Buyer pays to reserve a certain level of capacity at the supplier
  - A menu of prices for different capacity reservations provided by supplier
  - Buyer signals true forecast by reserving a specific capacity level

- Advance Purchase Contract
  - Supplier charges special price before building capacity
  - When demand is realized, price charged is different
  - Buyer’s commitment to paying the special price reveals the buyer’s true forecast

4.5 Contracts for Non-Strategic Components

- Variety of suppliers
- Market conditions dictate price
- Buyers need to be able to choose suppliers and change them as needed
- Long-term contracts have been the tradition
- Recent trend towards more flexible contracts
  - Offers buyers option of buying later at a different price than current
  - Offers effective hedging strategies against shortages

Long-Term Contracts

- Also called forward or fixed commitment contracts
- Contracts specify a fixed amount of supply to be delivered at some point in the future
- Supplier and buyer agree on both price and quantity
- Buyer bears no financial risk
- Buyer takes huge inventory risks due to:
  - Uncertainty in demand
  - Inability to adjust order quantities.

Flexible or Option Contracts

- Provide buyer with flexibility to adjust order quantities depending on realized demand
- Reduces buyer’s inventory risks.
- Shifts risks from buyer to supplier
  - Supplier is now exposed to customer demand uncertainty.
- Flexibility contracts
  - Related strategy to share risks between suppliers and buyers
  - A fixed amount of supply is determined when the contract is signed
  - Amount to be delivered (and paid for) can differ by no more than a given percentage determined upon signing the contract.

Flexible or Option Contracts

- Buyer pre-pays a relatively small fraction of the product price up-front
- Supplier commits to reserve capacity up to a certain level.
- Initial payment is the reservation price or premium.
- If buyer does not exercise option, the initial payment is lost.
- Buyer can purchase any amount of supply up to the option level by:
  - Paying an additional price (execution price or exercise price)
  - Agreed to at the time the contract is signed
  - Total price (reservation plus execution price) typically higher than the unit price in a long-term contract.

Spot Purchase

- Buyers look for additional supply in the open market.
- May use independent e-markets or private e-markets to select suppliers.
- Focus:
  - Using the marketplace to find new suppliers
  - Forcing competition to reduce product price.
Portfolio Contracts

- Portfolio approach to supply contracts
- Buyer signs multiple contracts at the same time
- Optimize expected profit
- Reduce risk.

Contracts
- Differ in price and level of flexibility
- Hedge against inventory, shortage and spot price risk.
- Meaningful for commodity products
  - A large pool of suppliers
  - Each with a different type of contract.

Appropriate Mix of Contracts

- How much to commit to a long-term contract?
  - Base commitment level.
- How much capacity to buy from companies selling option contracts?
  - Option level.
- How much supply should be left uncommitted?
  - Additional supplies in spot market if demand is high

Hewlett-Packard’s (HP) strategy for electricity or memory products
- About 50% procurement cost invested in long-term contracts
- 35% in option contracts
- Remaining is invested in the spot market.

Risk Trade-Off in Portfolio Contracts

- If demand is much higher than anticipated
  - Base commitment level + option level < Demand.
  - Typically the worst time to buy in the spot market
  - Prices are high due to shortages.

Buyer can select a trade-off level between price risk, shortage risk, and inventory risk by carefully selecting the level of long-term commitment and the option level.
- For the same option level, the higher the initial contract commitment, the smaller the price risk but the higher the inventory risk taken by the buyer.
- The larger the level of the base commitment, the higher the price and shortage risks due to the likelihood of using the spot market.
- For the same level of base commitment, the higher the option level, the higher the risk assumed by the supplier since the buyer may exercise only a small fraction of the option level.

CASE: H. C. Starck, Inc.

- Background and context
- Why are lead times long?
- How might they be reduced?
- What are the costs? benefits?

Metallurgical Products

- Make-to-order job shop operation
- 600 SKU’s made from 4” sheet bar (4 alloys)
- Goal to reduce 7-week customer lead times
- Expediting is ad hoc scheduling rule
- Six months of inventory
- Manufacturing cycle time is 2 – 3 weeks
- Limited data
Why Is Customer Lead Time 7 Weeks?

- From sales order to process order takes 2 weeks
- Typical order requires multiple process orders, each 2 – 3 weeks
- Expediting as scheduling rule
- Self fulfilling prophecy?

What Are Benefits from Reducing Lead Time?

- New accounts and new business
- Protect current business from switching to substitutes or Chinese competitor
- Possibly less inventory
- Better planning and better customer service
- Savings captured by customers?

How Might Starck Reduce Customer Lead Times?

- Hold intermediate inventory
  - How would this help?
  - How much? Where?
- Eliminate paper-work delays
- Reduce cycle time for each process order
  - How? What cost?

Two-Product Optimal Cycle Time

\[
\text{Cost}(T) = \frac{K_B + K_F}{T} + T \left( \frac{h_B D_B + h_F D_F}{2} \right)
\]

\[
T^* = \frac{2(K_B + K_F)}{h_B D_B + h_F D_F}
\]

\[
T^* = \frac{2(400 + 400)}{0.06 \times 100 \times 526000 + 0.06 \times 125 \times 183000} = 0.02 \text{ years}
\]

Intermediate Inventory

- Characterize demand by possible intermediate for each of two alloys
- Pick stocking points based on risk pooling benefits, lead time reduction, volume
- Determine inventory requirements based on inventory model, e.g. base stock
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**Note:** (Top 20 Items - 98% of Sales)
### Case Summary

- Demonstrate applicability of risk pooling and postponement, EOQ modeling, and inventory sizing to improve customer service in make-to-order job shop setting
- Demonstrates value from getting and looking at data

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Estimated Inventory Requirements