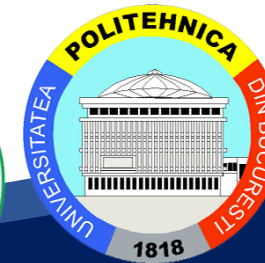




Co-funded by the
Erasmus+ Programme
of the European Union



Sustainable Supply Chain Management



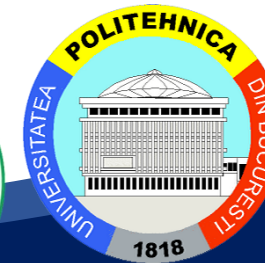
Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry



Co-funded by the
Erasmus+ Programme
of the European Union



Supply Contracts



Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

- Significant level of outsourcing in the last few years
- 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



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.



Supply Contracts

- Consider a 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
 - Purchase based on forecast of customer demand
- 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



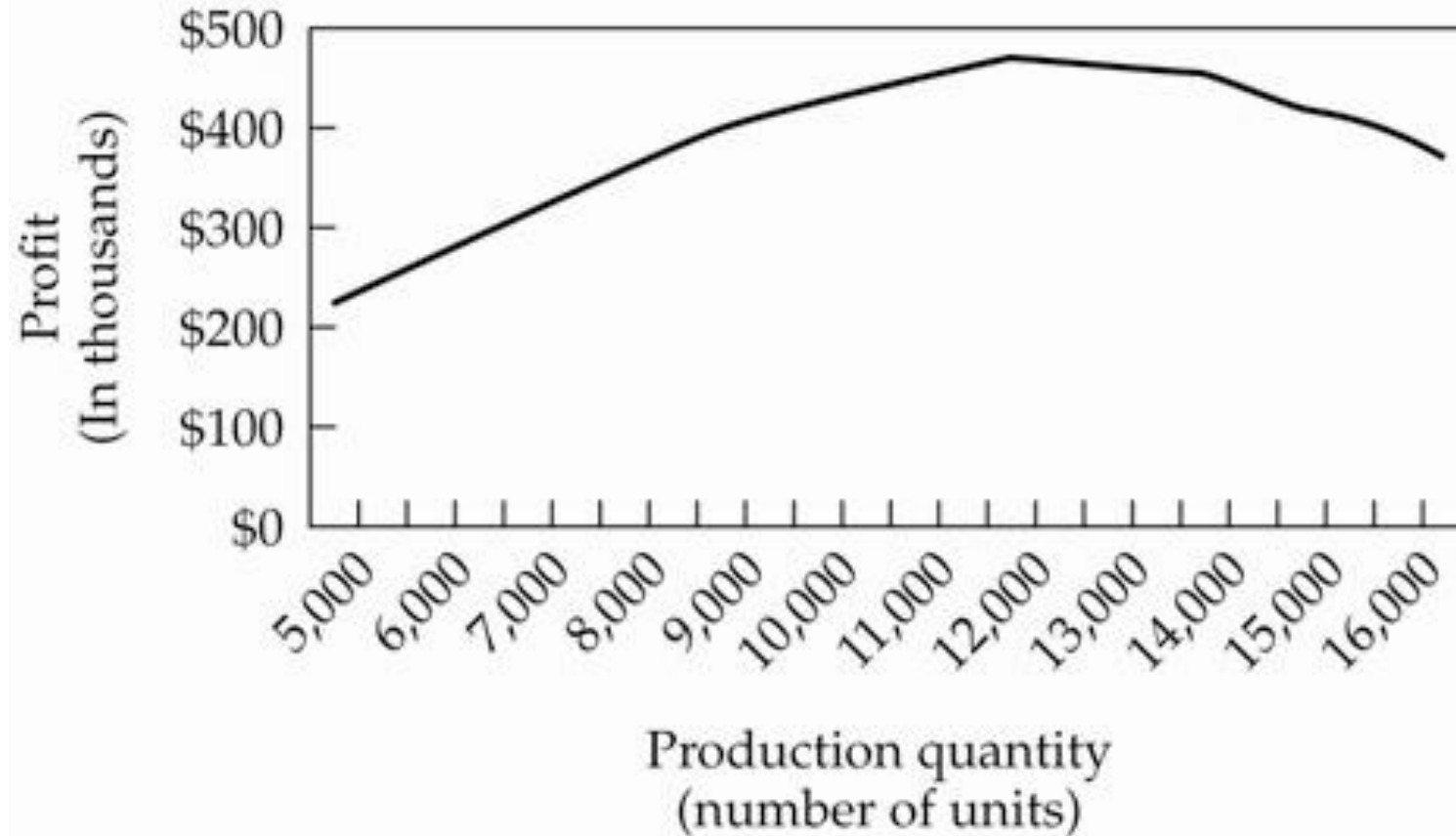


What Is the Optimal Order Quantity?

- 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 $12,000(80 - 35) - 100,000 = \$440,000$



Sequential Supply Chain



Retailer's expected profit as a function of order quantity

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

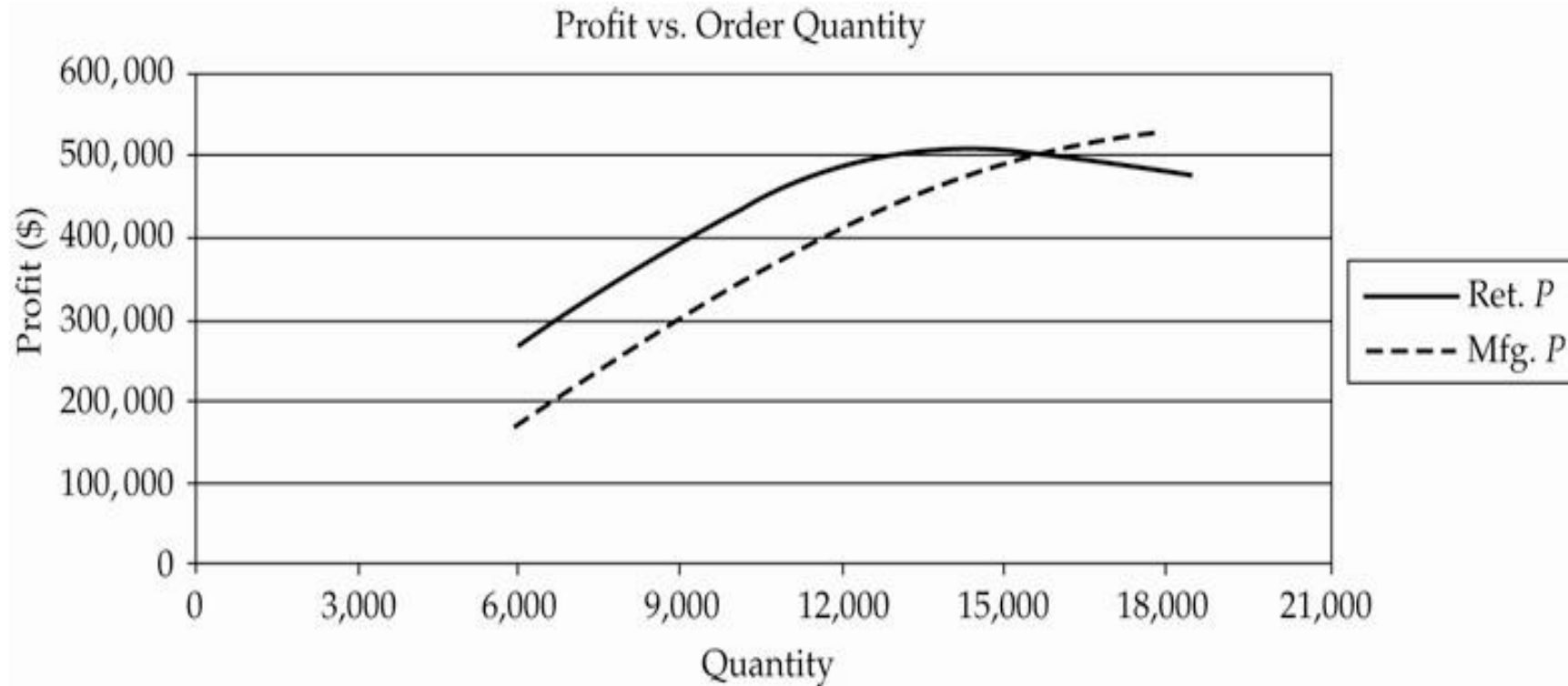


Buy-Back Contract Swimsuit Example

- 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)



Buy-Back Contract Swimsuit Example



Buy-back contract





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



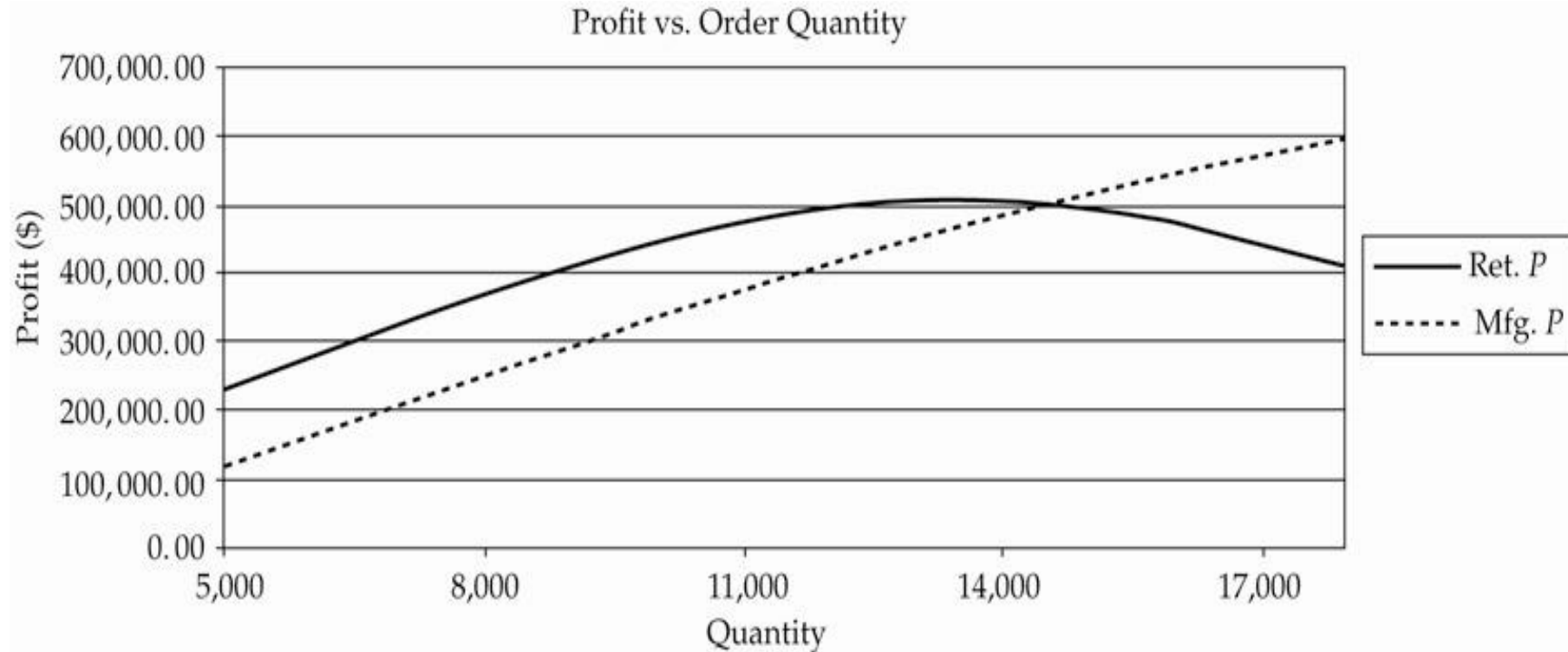


Revenue Sharing Contract Swimsuit Example

- 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).



Revenue Sharing Contract Swimsuit Example



Revenue-sharing contract

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

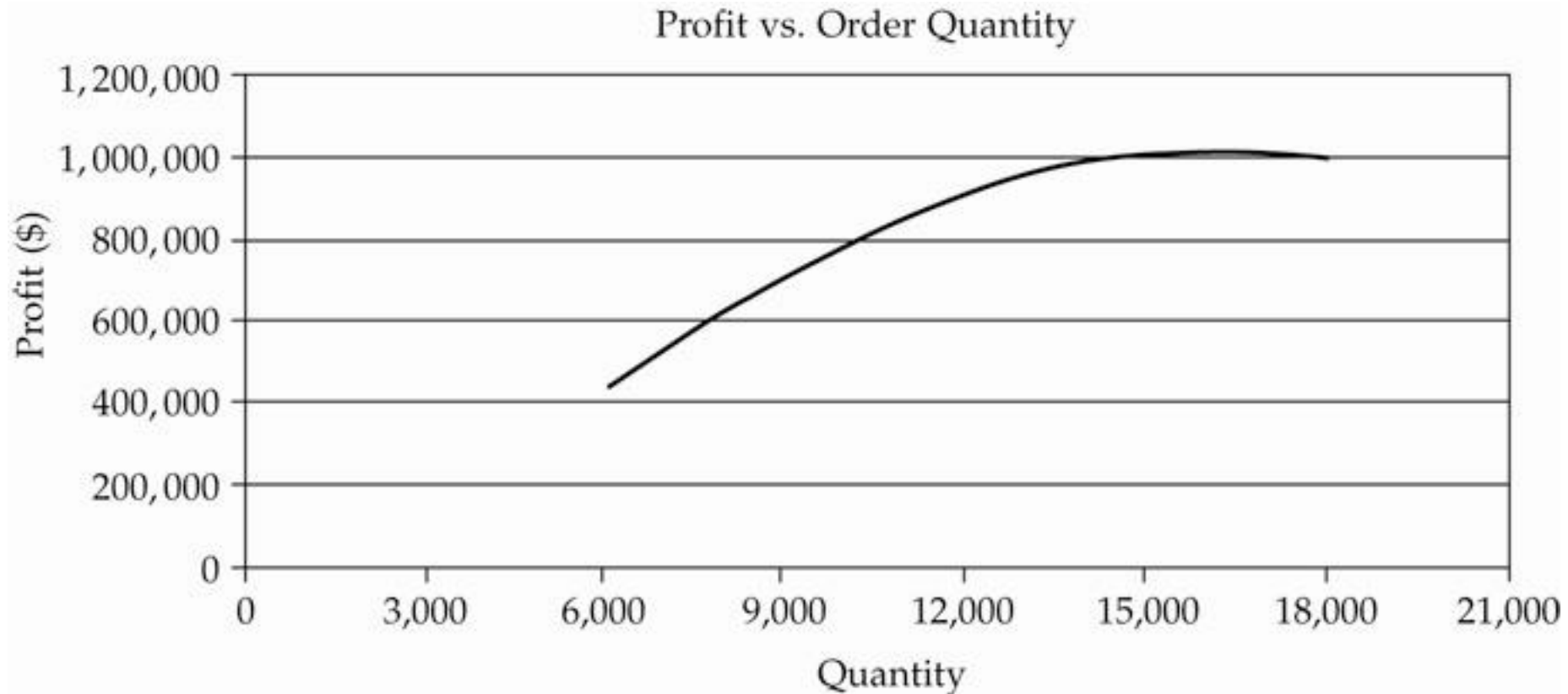


Global Optimization Swimsuit Example

- 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 Swimsuit Example



Profit using global optimization strategy



Global Optimization and Supply Contracts

- Unbiased decision maker is 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.
 - Retailer's risk is much higher for the products not under the buy back contract (competing products!).

- **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.





Contracts for Make-to-Stock & Make-to-Order Supply Chains

- Previous contracts examples were with Make-to-Order supply chains
- What happens when the supplier has a Make-to-Stock situation?





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.

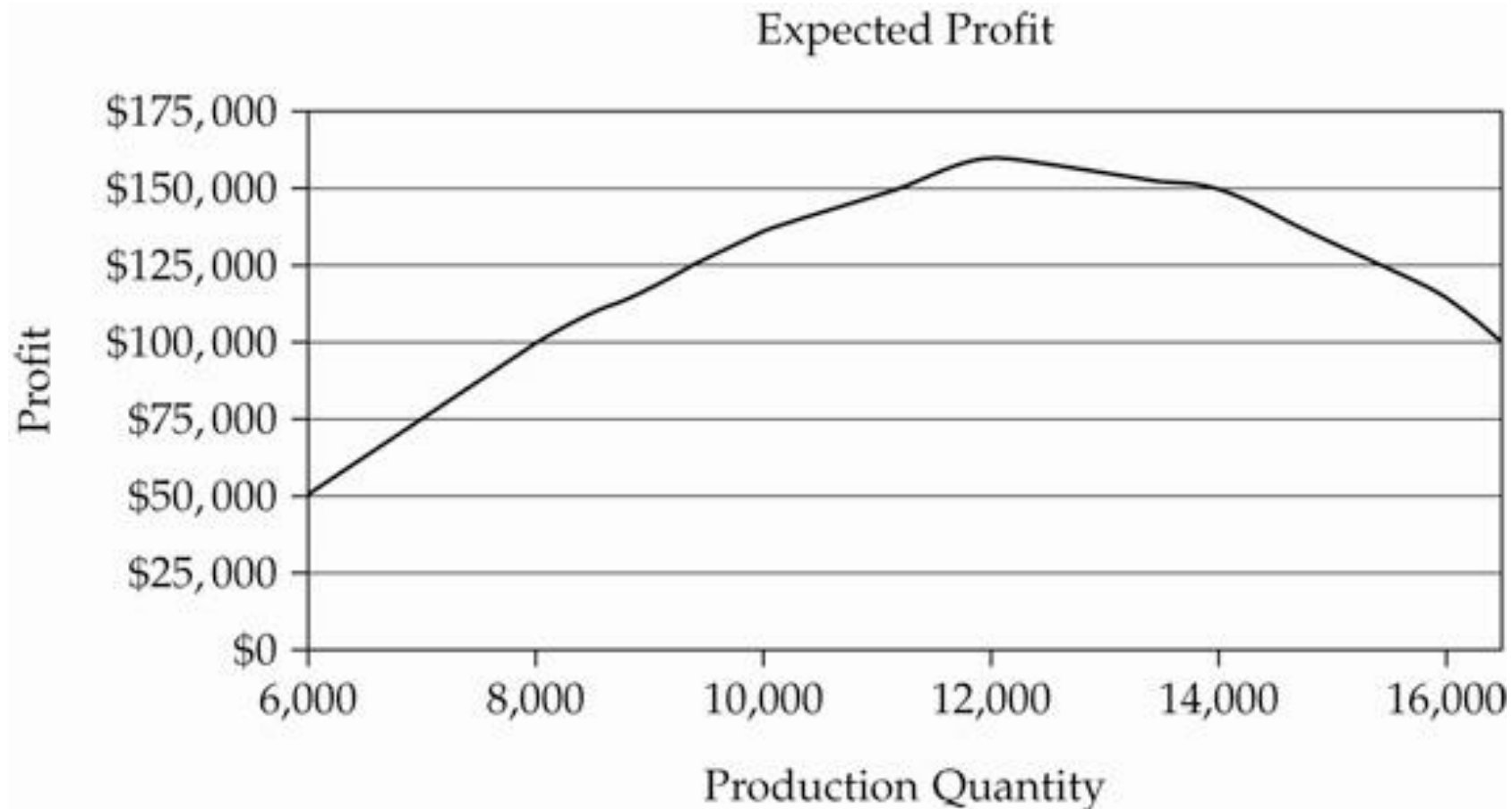


Profit and Loss

- For the manufacturer
 - Marginal profit = \$25
 - Marginal loss = \$35.
 - Since marginal loss is greater than marginal profit, the distributor should produce less than average demand, i.e., less than 13, 000 units. (Demand pattern: see Ex. 2.3)
- 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



Manufacturer's expected profit

Co-funded by the
Erasmus+ Programme
of the European Union





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 prod. quantities has to compensate the distributor for the increase in risk.



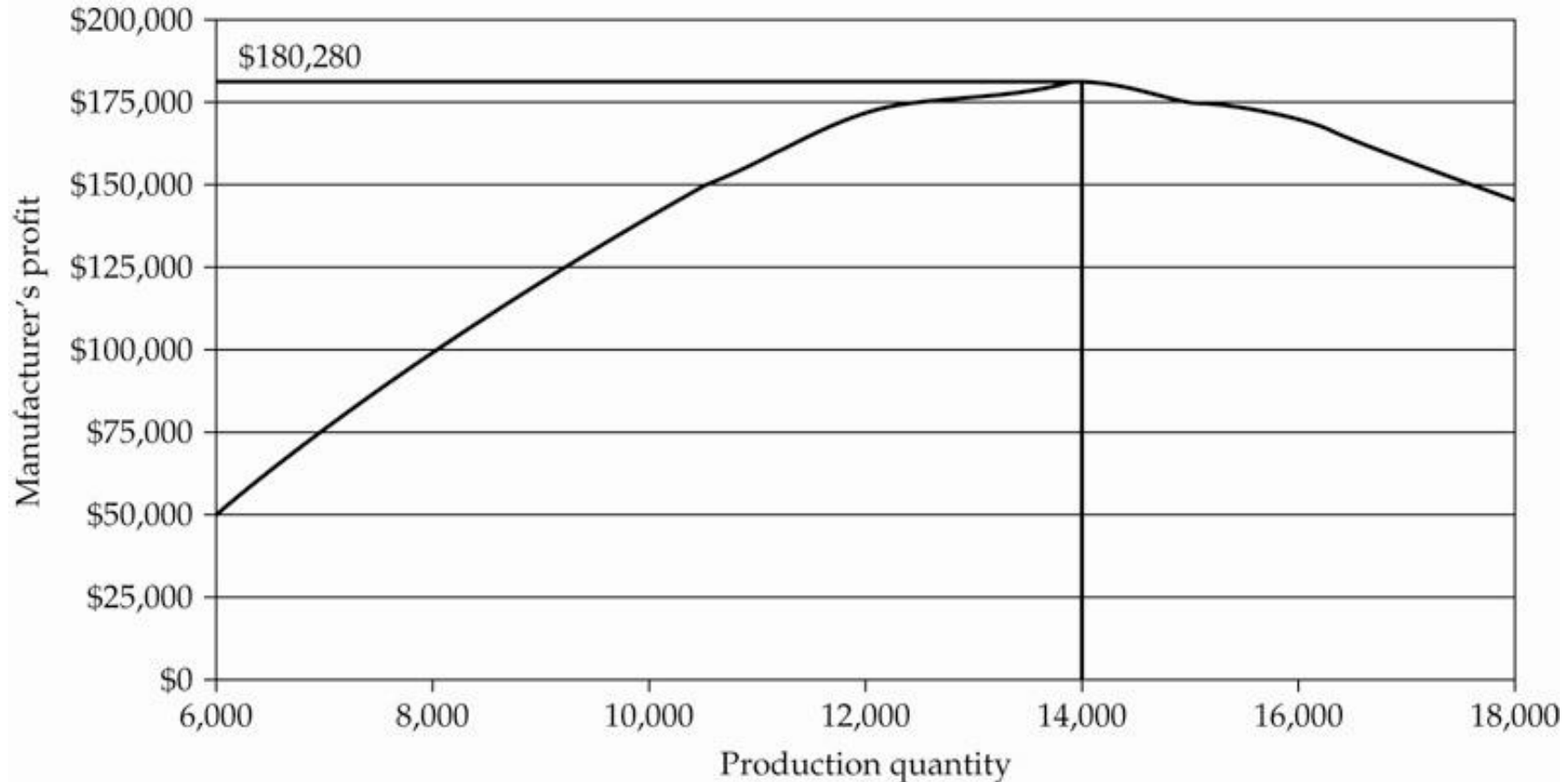


Pay-Back Contract Ski Jacket Example

- 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)

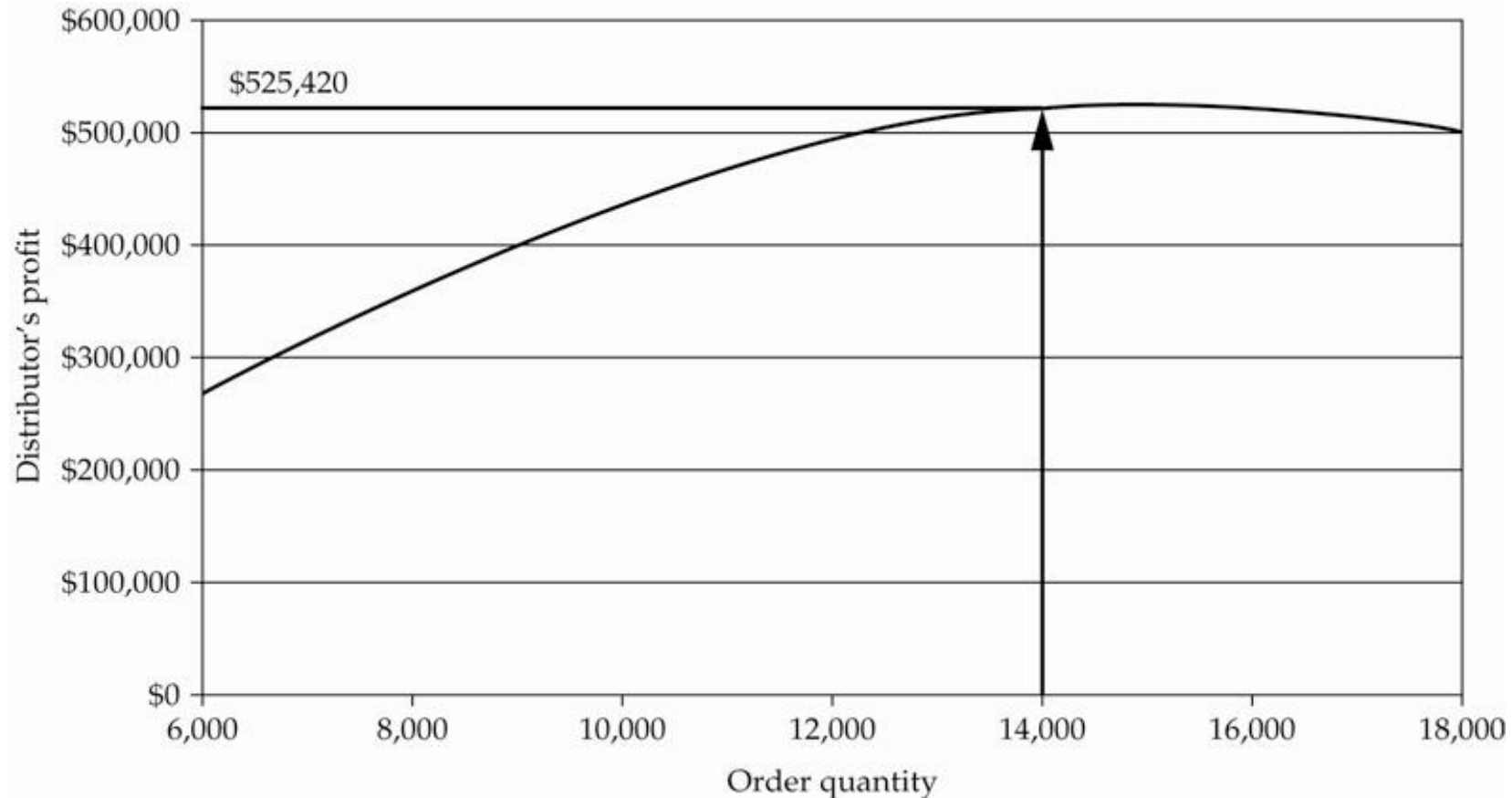


Pay-Back Contract Ski Jacket Example



Manufacturer's average profit (pay-back contract)

Pay-Back Contract Ski Jacket Example (cont)



Distributor's average profit (pay-back contract)



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





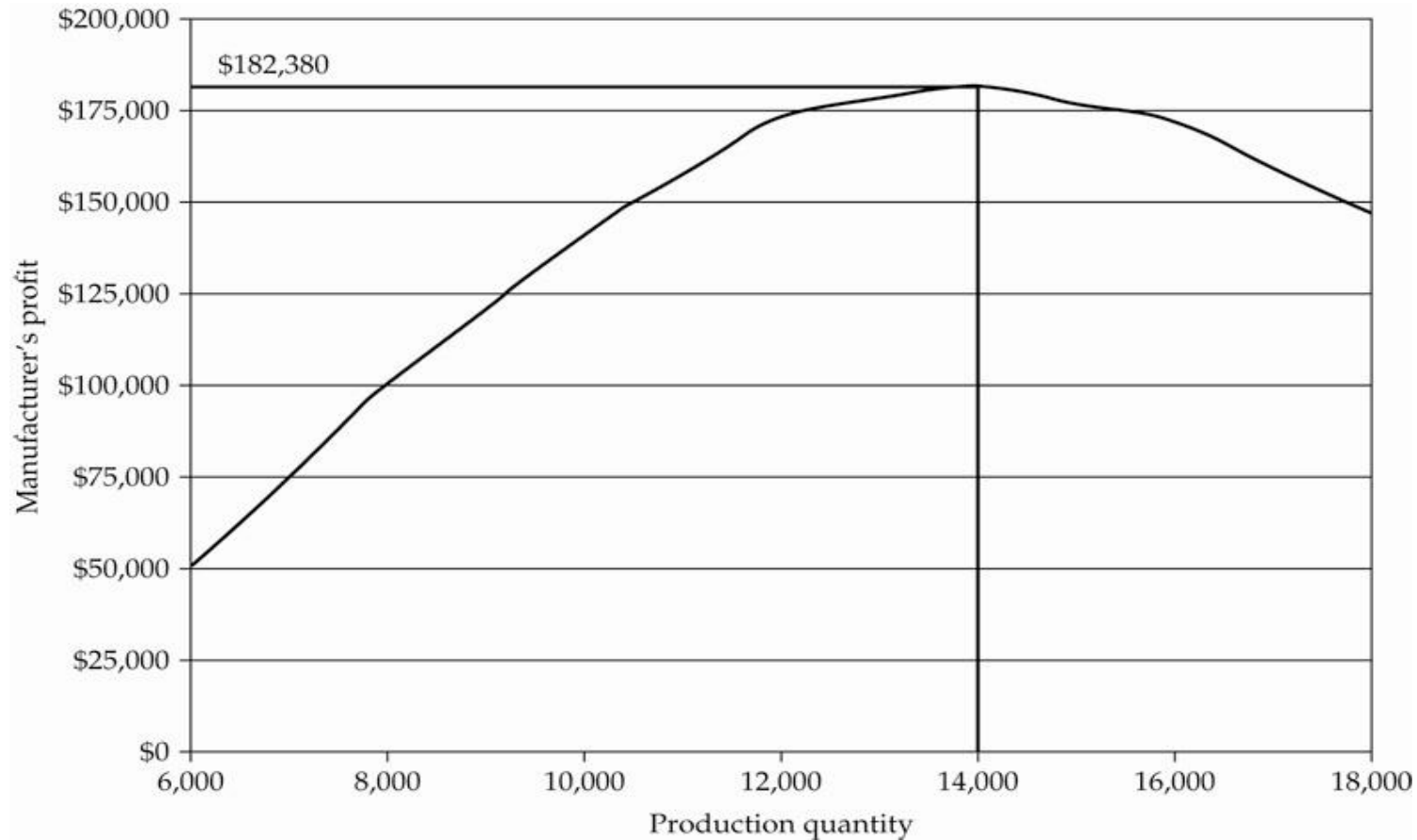
Cost-Sharing Contract Ski-Jacket Example

- 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

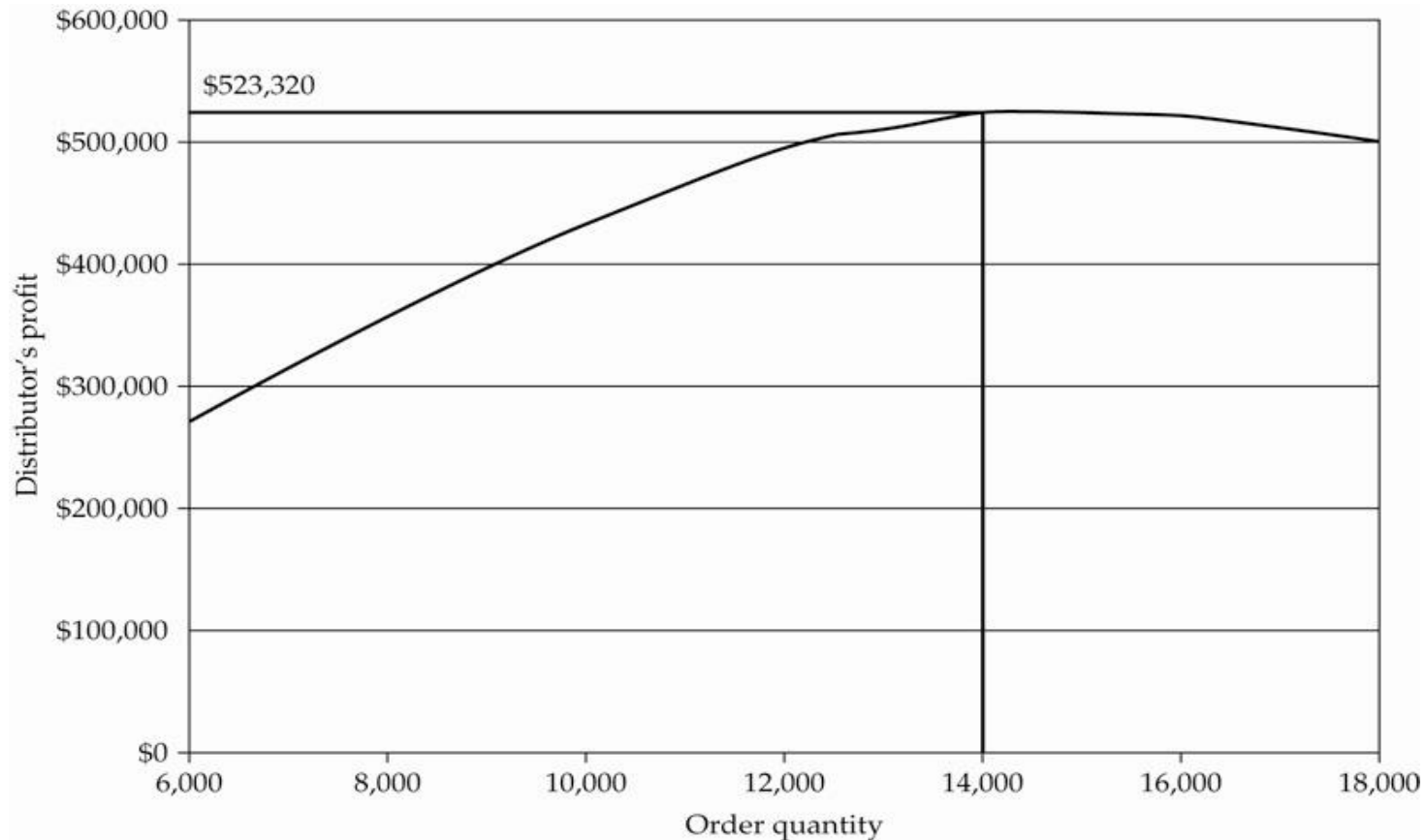


Cost-Sharing Contract Ski-Jacket Example



Manufacturer's average profit (cost-sharing contract)

Cost-Sharing Contract Ski-Jacket Example (cont)



Distributor's average profit (cost-sharing contract)



Implementation Issues

- Cost-sharing contract requires manufacturer to share production cost information with distributor, something manufacturers are reluctant to do
- So, how? → 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.

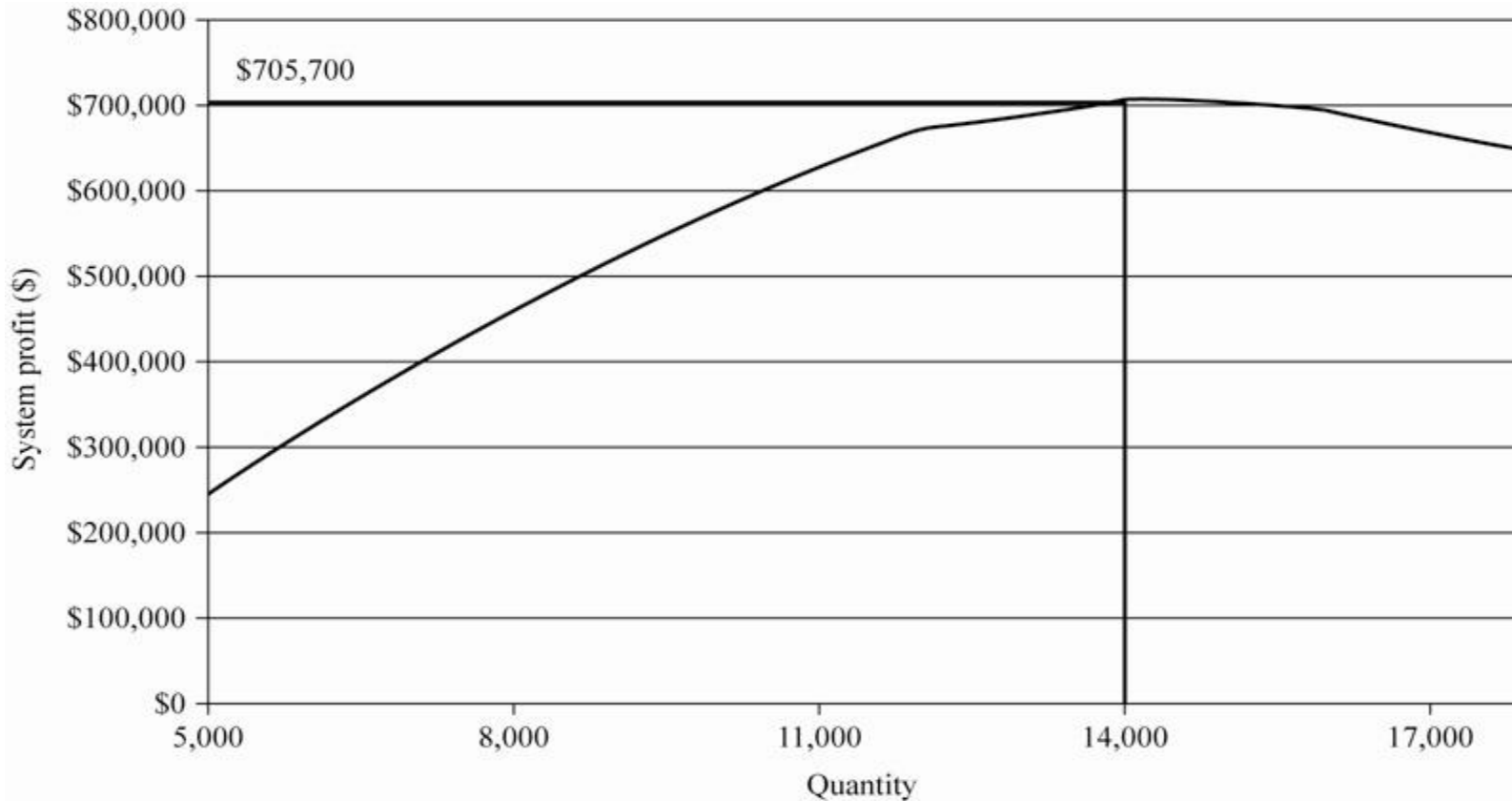


- Relevant data:
 - Selling price, \$125
 - Salvage value, \$20
 - Variable production costs, \$55
 - Fixed production cost. \$100,000
- Cost that the distributor pays the manufacturer is meaningless
- Supply chain marginal profit, $70 = 125 - 55$
- Supply chain marginal loss, $35 = 55 - 20$
 - Supply chain will produce more than average demand.
- Optimal production quantity = 14,000 units
- Expected supply chain profit = \$705,700

Same profit as under pay-back and cost sharing contracts



Global Optimization



Global optimization

Co-funded by the
Erasmus+ Programme
of the European Union





Contracts with Asymmetric Information

- Implicit assumption so far: Buyer and supplier share the same forecast
- However, inflated forecasts from buyers is 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





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
 - Purchase supply now or wait for better market condition in the future
 - Consider effective hedging strategies against unfavorable situations (i.e., 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.*



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.



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.





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 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

Low Price + Low Flexibility vs. Reasonable Price + Better Flexibility

- 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,
 - Firm must use spot market for additional supply.
 - 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 smaller 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.



Risk Trade-Off in Portfolio Contracts

		Low	High
		Base commitment level	
Option level	High	Inventory risk (supplier)	N/A*
	Low	Price and shortage risks (buyer)	Inventory risk (buyer)

*For a given situation, either the option level or the base commitment level may be high, but not both.