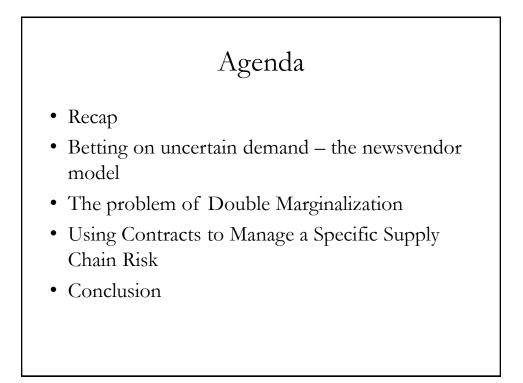
# Supply Chain Coordination using contracts



RECAP

# Sunglasses supply chain

- Refer Handout
- How many units of 'Bassano' should the UV's Maimi beach store order?

### Newsvendor model

- Inventory decision under uncertainty
- The "too much/too little problem":
  - Order too much and inventory is left over at the end of the season
  - Order too little and sales are lost.
- Can be generalized to many other contexts
  - Fire crackers
  - Apparel seasonal time horizon
  - Airline seat class perishable service
  - Electronic goods with upgrade cycles

### Notation

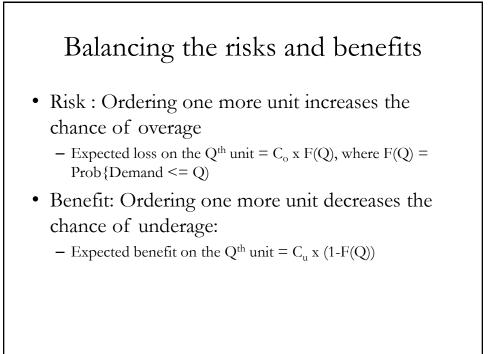
- Demand **D** is a random variable
  - Cumulative distribution function F(D)
- Wholesale price **W**
- Selling price **R**
- Salvage value **S** (**<W**)
- How much should the retailer order?

### "Too much" and "too little" costs

- $C_{o}$  = overage cost
  - The cost of ordering one more unit than what you would have ordered had you known demand.
  - Increase in profit you would have enjoyed had you ordered one unit lesser.
  - For UV,  $C_o = Cost Salvage value = W S = Solve here$

### • $C_{u}$ = underage cost

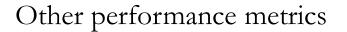
- The cost of ordering one fewer unit than what you would have ordered had you known demand.
- Increase in profit you would have enjoyed had you ordered one unit more.
- For UV,  $C_u = Price Cost = R W = Solve here$
- · How many units of 'Bassano' should the Maimi beach store order?



# Expected profit maximizing order quantity To minimize the expected total cost of underage and overage, order Q units so that the expected marginal cost with the Q<sup>th</sup> unit equals the expected marginal benefit with the Q<sup>th</sup> unit: C<sub>o</sub>×F(Q) = C<sub>u</sub>×(1-F(Q)) Rearrange terms in the above equation -> F(Q) = C<sub>u</sub>/C<sub>o</sub>+C<sub>u</sub> The ratio C<sub>u</sub> / (C<sub>o</sub> + C<sub>u</sub>) is called the *critical ratio*. In other terms, (R-W)/(R-S). R and S are determined by the market. UV's ordering decision - excel file Critical ratio = (115-75)/(115-25)= 0.444

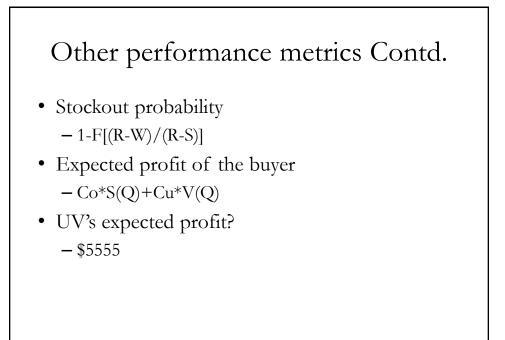
# Determination of the final ordering quantity

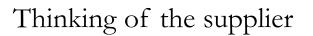
- Final ordering quantity
  - $Q^* = F^{-1}[(R-W)/(R-S)]$
- Final Ordering Quantity
  - Norm.inv(0.444,250,125) = 234 units



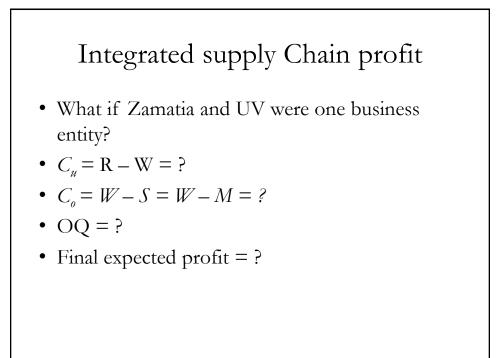
- Other performance metrics
  - Expected number of shortages given the ordering quantity
    - $L(Q) = \sigma * L(z)$ 
      - -L(z): probability loss function
  - Expected sales given the ordering quantity
    - $S(Q) = \mu L(Q)$
  - Expected leftover

• 
$$V(Q) = Q-S(Q)$$



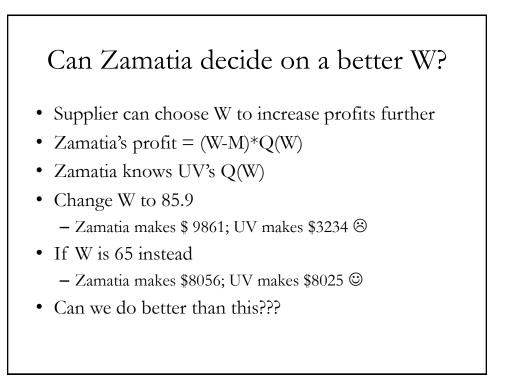


- Zamatia's manufacturing cum shipping costs per unit of 'Bassano'
  - **– M =** \$35
- Zamatia's profit?
   234\*\$75 234\*\$35=\$9360
- Put together both are now earning
   \$5555 + \$9360 = \$14915



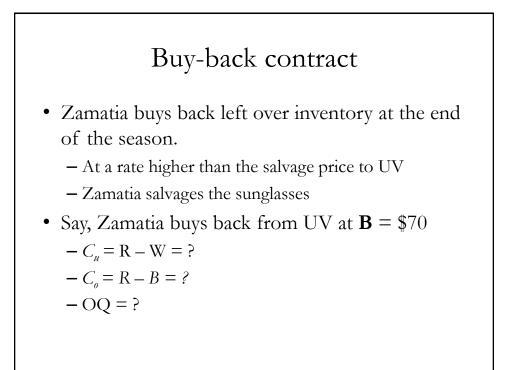
### Double Marginalization

- Why does the supply chain perform significantly worse than it could?
  - UV maximizing its own profit
  - UV stocking less
  - Actual production cost does not matter for UV
- Even if every firm in a supply chain chooses actions to maximize its own expected profit, the total profit earned in the supply chain may be less than the entire supply chain's maximum profit.



### Aligning incentives...

- Marginal cost pricing:
  - Zamatia charges \$35 per sunglass, then UV's critical ratio equals the supply chain's critical ratio.
  - But Zamatia makes zero profit.
- What they need is a method to share inventory risk so that the supply chain's profit is maximized (coordinated) and both firms are better off.



### More on buy-back contracts

- How do they improve supply chain performance?
  - The retailer's overage cost is reduced, so the retailer stocks more.
  - With a buy-back the supplier shares with the retailer the risk of left over inventory.
- Other uses for buy-back contracts:
  - Allow for the redistribution of inventory risk across the supply chain.
  - Helps to protect the supplier's brand image by avoiding markdowns.
  - Allows the supplier to signal that significant marketing effort will occur.

### Role of Power

What if one of the player is more powerful?
They would seek a higher proportion of profit.

### Other methods to align incentives

- Revenue sharing:
  - Supplier accepts a low upfront wholesale price in exchange for a share of the revenue.
  - Under appropriately chosen parameters, the retailer has an incentive to stock more inventory, thereby generating more revenue for the supply chain.

# Comparing RS and BB contracts

### **Buyback contracts**

### **Revenue Sharing contracts**

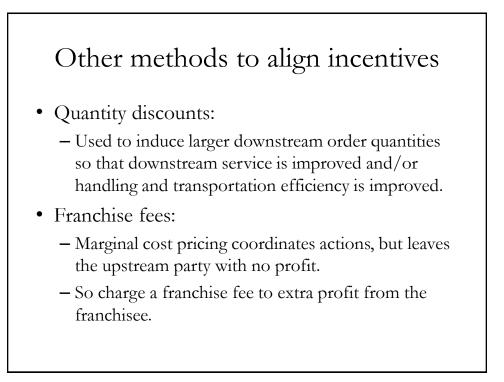
- Buyback contracts
   Reduces overage costs
- Revenue Sharing contracts
   Reduces underage cost

For every buyback contract, there is an equivalent revenue sharing contract.

$$W_B = W_R + r; B = r + S$$

### Options contract

- What are they?
  - The buyer purchases the option to buy at a future time.
  - Each option costs  $p_a$  and it costs  $p_e$  to exercise each option.
- How can they improve supply chain performance?
  - Provides an intermediate level of risk:
    - Fixed long term contract requires a commitment at a price greater than  $p_{\sigma}$ .
    - Procuring on the volatile spot market could lead to a price greater than  $p_o + p_e$ .
- Where are they used?
  - Semiconductor industry, energy markets (electric power), commodity chemicals, metals, plastics, apparel retailing, air cargo, ...



### Downsides of contracts

- Determination of the right set of contract parameters is a challenge
- Additional administrative burden
- Verification costs
- Arbitrage/credit risk
- Impact of sales effort
- Multiple competing retailers

### Summary

- Coordination failure:
  - Supply chain performance may be less than optimal with decentralized operations (i.e., multiple firms making decisions) even if firms choose individually optimal actions.
- A reason for coordination failure:
  - The terms of trade do not give firms the proper incentive to choose supply chain optimal actions.
- Why fix coordination failure:
  - If total supply chain profit increase, the "pie" increases and everyone can be given a bigger piece.
- How to align incentives:
  - Design terms of trade to restore a firm's incentive to choose optimal actions.

