MS&E 260

Introduction to Operations Management

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Supply Chain Contracts Introduction

Definitions of Supply Chain Management

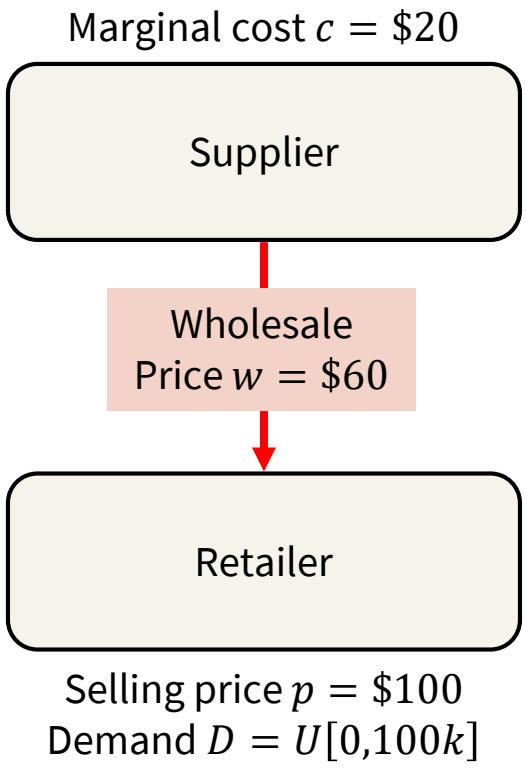
- “Supply chain management deals with the management of materials, information, and financial flows in a network consisting of suppliers, manufacturers, distributors, and customers.” (Stanford Supply Chain Forum)
- “Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize systemwide costs while satisfying service level requirements.” (Simchi-Levi)
- “Call it distribution or logistics or supply chain management. By whatever name, it is the sinuous, gritty, and cumbersome process by which companies move material, parts, and products to customers. In industry after industry, from cars to clothing to computers and chemicals, executives have plucked this once dismal discipline off the loading dock and placed it near the top of the corporate agenda. Hard-pressed to knock out competitors on quality or price, companies are trying to gain an edge through their ability to deliver the right stuff in the right amount at the right time.” (Fortune magazine)

SCM Big Picture

- Primary tradeoff in SCM models: cost versus response time
  - e.g. less costly to transport goods by truck or boat, but air freight is faster
  - e.g. tradeoff between internal delivery system vs. third party logistics
- Example: Trimble Corporation: producers of GPS systems
  - Realized that core competency was design, not manufacturing of GPS systems
  - In late 1990s, closed their manufacturing facilities and now subcontracts manufacturing to Solectron
- Since manufacturing is now a commodity service that is outsourced, cost reductions come from the ***supply chain***
  - Bottom line: firms that *move products quickly and efficiently* will win
- In this lecture, we will focus on just one aspect of supply chain management: **Supply Chain Contracts**
- For more in-depth treatment of SCM: MS&E 262: Supply Chain Management

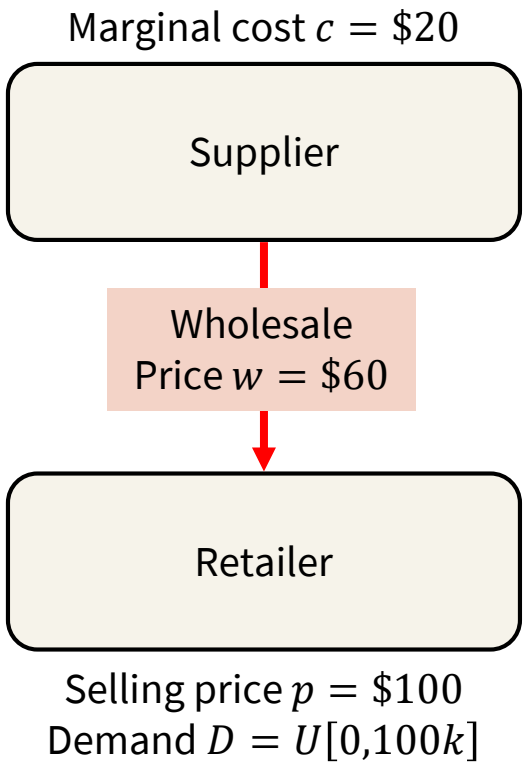
Two Firm Supply Chain

- Estimated total market demand D for product with 3 month life cycle is uniform between 0 and 100,000 units
- Productions and distribution cost: $c = \$20$ per unit
- Wholesale price (buying from supplier): $w = \$60$ per unit
- The product is sold at a retail price $p = \$100$ per unit
- No salvage value
- **Question**: What is the optimal order quantity Q^* from the Retailer?
- **Question**: What is the expected profit for S (supplier) and R (retailer)?



Two Firm Supply Chain

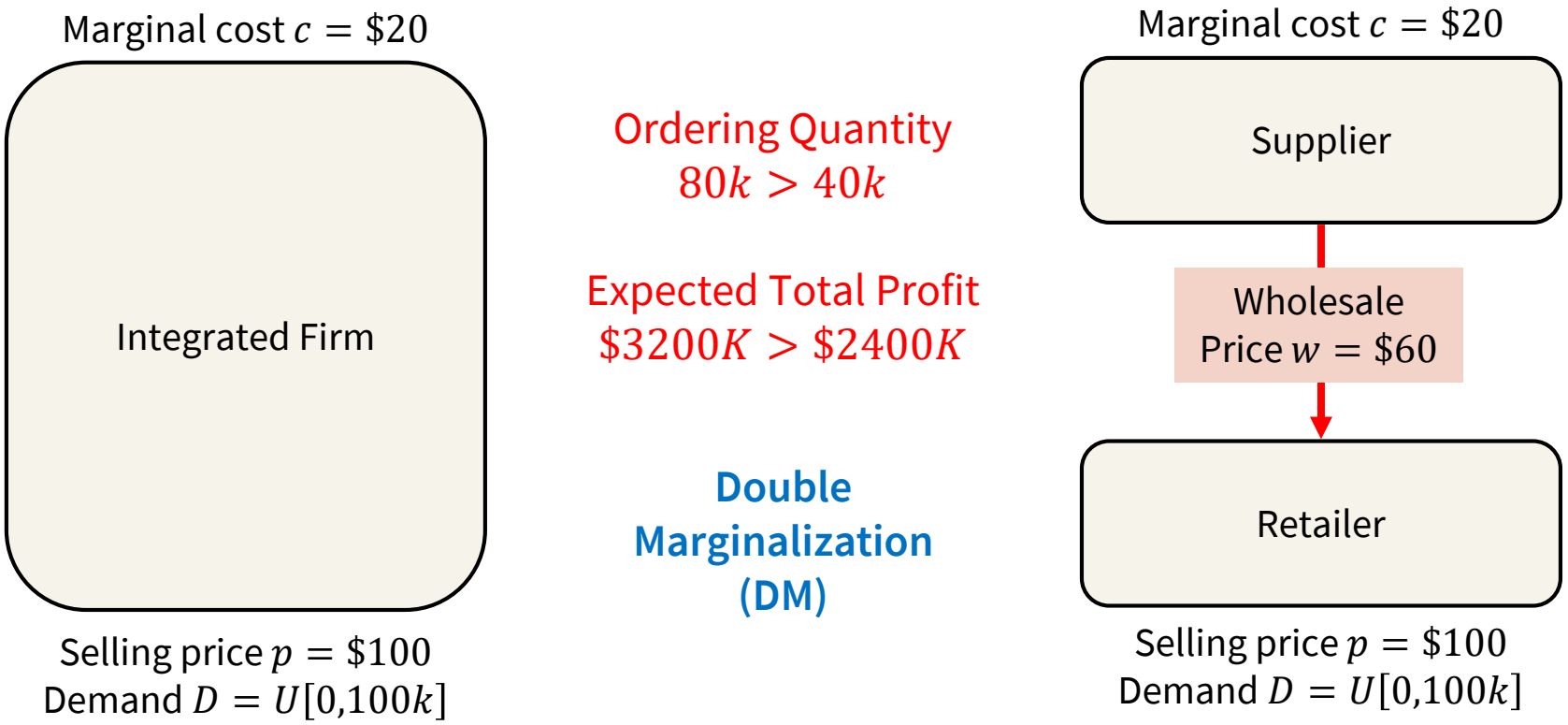
- Retailor is solving a newsvendor problem!
- For retailor:
  - $Underage\ cost = 100 - 60 = 40$
  - $Overage\ cost = 60$
- Critical ratio: $40/(40+60) = 0.4$
- $Q^* = 0.4 \times 100k$
- Expected sales: $(40k \times 0.4)/2 + 0.6 \times 40k = 32k$
- $E[profit\ for\ R] = 100 \times 32k - 60 \times 40k = 800k$
- $E[profit\ for\ S] = (60 - 20) \times 40k = 1600k$
- $E[total\ profit] = 800k + 1600k = 2400k$



Vertically Integrated Firm

- Suppose the firm owns both parts of the supply chain (retail and manufacturing):
  - Question: What is the optimal order quantity Q^*?
  - Question: What is the expected profit for the firm?
- $Underage\ cost = 80$
- $Overage\ cost = 20$
  - $\Rightarrow$ Critical ratio is 0.8
- $Q^* = 80k$
- $E[sales] = 0.8 \times 80k/2 + 0.2 \times 80k = 48k$
- $E[profit] = 100 \times E[sales] - 20 \times 80k = 3200k$

Integrated Firm vs. Two-Firm Supply Chain



How can we overcome this gap?

Naïve Solution: Reduce the Wholesale Price

Wholesale price (w)	60	50	40	30	20 (Manufacturing Cost)
Q^*	40K	50K	60K	70K	80K
Retailer Profit	800K	1250K	1800K	2450K	3200K
Supplier Profit	1600K	1500K	1200K	700K	0
Total Supply Chain Profit	2400K	2750K	3000K	3150K	3200K

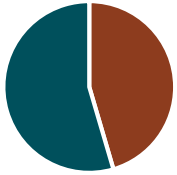
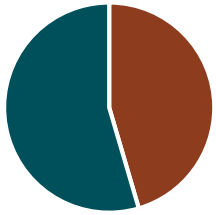
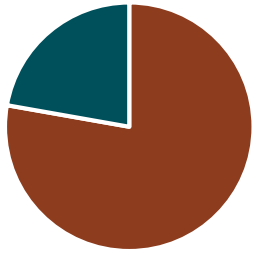
Reduce the Wholesale Price

- Makes the pie bigger – we reach the maximum supply chain profit (= integrated firm profit)



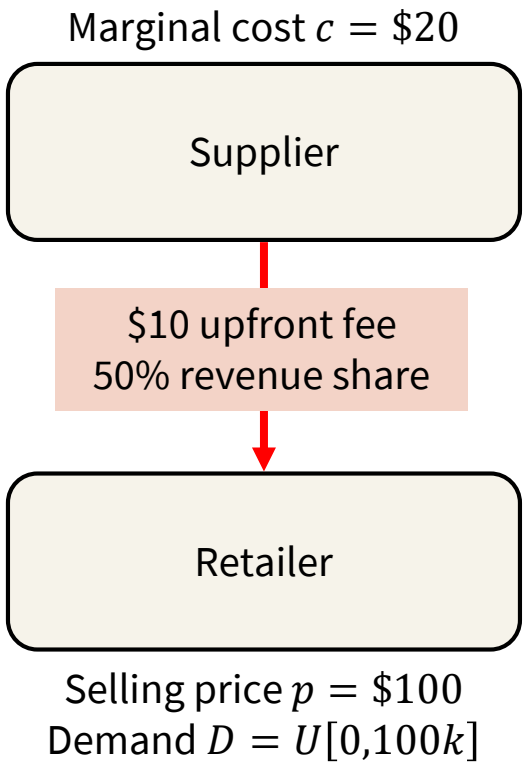


- Supplier gets no share of this bigger pie

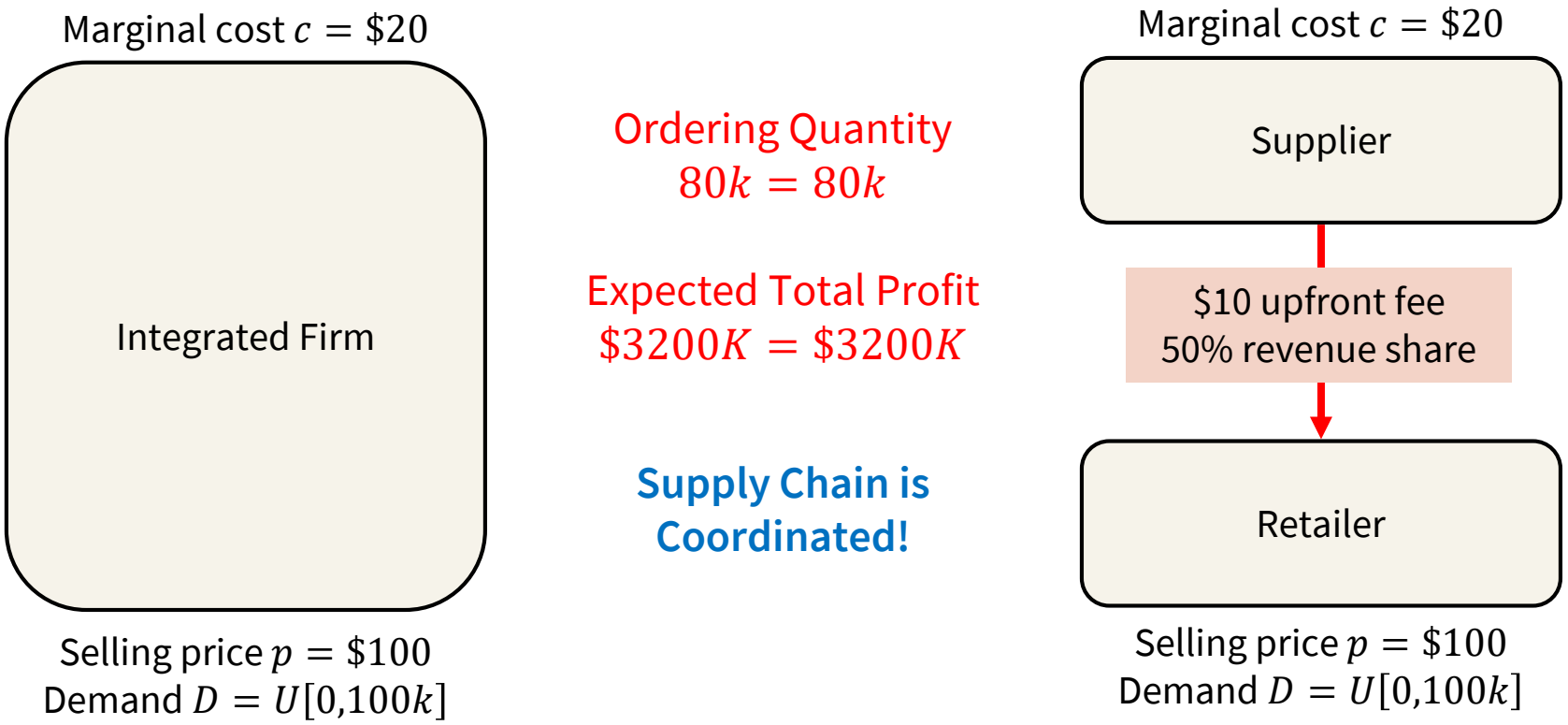






Revenue Sharing Contract

- Optimal order quantity Q^* from R?
- Expected profit for S, R, SC?
- For retailor:
  - $Underage\ cost = 0.5 \times 100 - 10 = 40$
  - $Overage\ cost = 10$
- Critical ratio: $40/(40+10) = 0.8$
- $Q^* = 80k$ (same as in the integrated firm – coordinated!)
- Expected sales: $48k$
- $E[profit\ for\ R] = 0.5 \times 100 \times 48k - 10 \times 80k = 1600k$
- $E[profit\ for\ S] = 0.5 \times 100 \times 48k + (10 - 20)80k = 1600k$
- $E[total\ profit] = 3200k$



Integrated Firm vs. Revenue Sharing Contract



Revenue Sharing Profit Allocation

Upfront fee	4	6	8	10	12	14	16
Retailer revenue share	20%	30%	40%	50%	60%	70%	80%
Q*	80K	80K	80K	80K	80K	80K	80K
Retailer profit	640K	960K	1,280K	1,600K	1,920K	2,240K	2,560K
Supplier profit	2,560K	2,240K	1,920K	1,600K	1,280K	960K	640K
Total supply chain profit	3,200K	3,200K	3,200K	3,200K	3,200K	3,200K	3,200K

Both supplier and retailer earn higher profit than in original wholesale price contract!

How Do We Find the Right Prices?

- Given:
  - p = retail price
  - c = cost per unit to the supplier
  - s = salvage value
  - f = upfront fee
  - θ = revenue share percentage

$$\frac{p-c}{(p-c)+c-s} = \frac{\theta p - f}{(\theta p - f)+f-s} \Rightarrow \frac{p-c}{p-s} = \frac{\theta p - f}{\theta p - s}$$

Original Critical Ratio

Critical Ratio Under Revenue Sharing

- Any θ and f that satisfies this expression will coordinate the supply chain!

How Do We Find the Right Prices?

- Integrated firm: critical ratio $= (p - c)/p$
- Revenue sharing contract: critical ratio $= (\theta p - f)/\theta p$

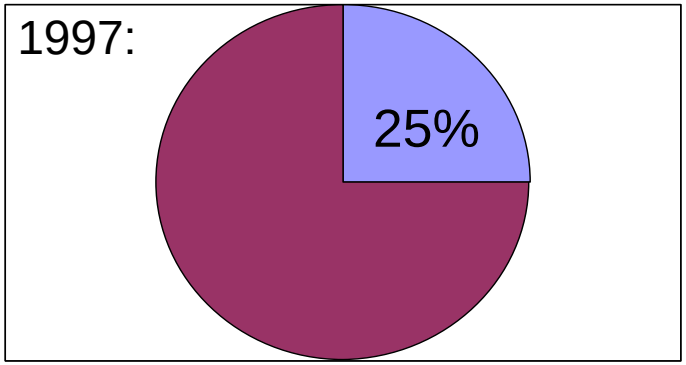
$$\frac{p - c}{p} = \frac{\theta p - f}{\theta p}$$

- Supply chain coordination = Equalizing target service level!
- Any pair $\{\theta, f = \theta c\}$ can coordinate the supply chain

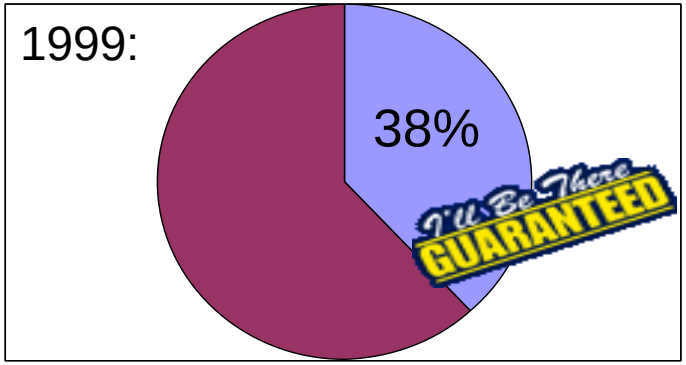
DVD Rental Industry

- Before revenue sharing (pre 1998):
  - Rentals shrinking, sales declines, 20% of surveyed customers can't find what they want

Blockbuster market share



- After revenue sharing (1998+):
  - Blockbuster negotiated revenue sharing deals with all the studios
  - Begins the "Go home happy" campaign
  - Total industry profit increased by about 7% (Mortimer 2003)

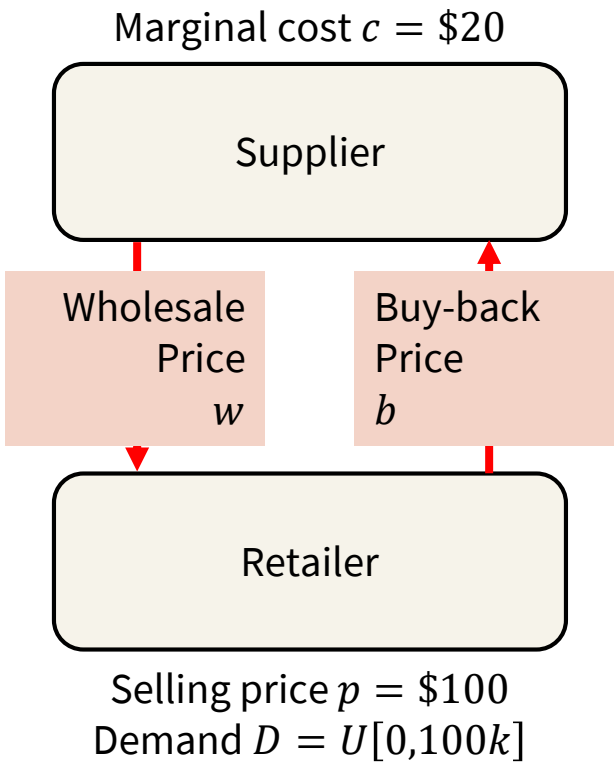


Buy-Back Contract

- To coordinate the supply chain coordination equalize target service level!

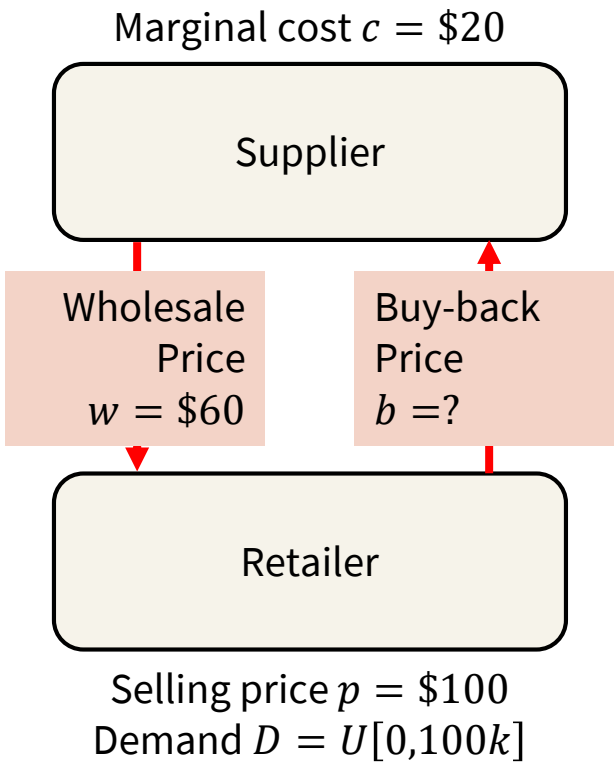
$$\frac{p-c}{p} = \frac{p-w}{p-w+w-b}$$

$$\Rightarrow b = p - (p-w) \times \frac{p}{p-c}$$



Buy-Back Contract

- Question: What is the buy back price for $w = \$60$ that coordinates the supply chain?



Buy Back Profit Allocation

Wholesale	30	40	50	60	70	80
Buy back	12.5	25	37.5	50	62.5	75
Q*	80K	80K	80K	80K	80K	80K
Retailer profit	2800K	2400K	2000K	1600K	1200K	800K
Supplier profit	400K	800K	1200K	1600K	2000K	2400K
Total supply chain profit	3,200K	3,200K	3,200K	3,200K	3,200K	3,200K

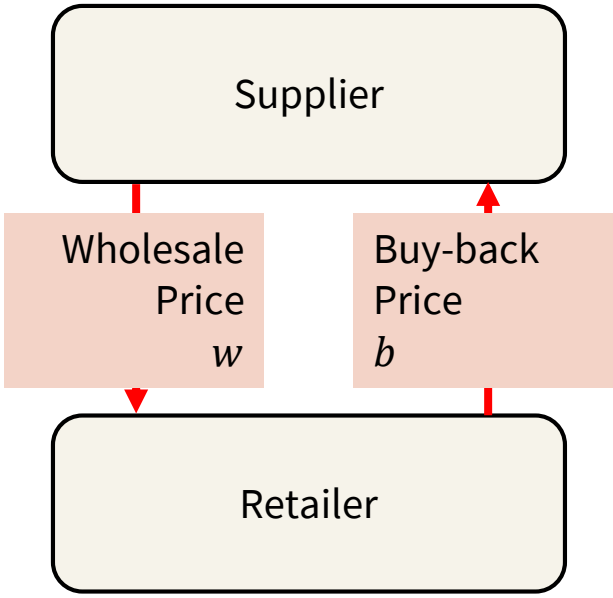
Both supplier and retailer earn higher profit than in original wholesale price contract!

Buy-Back Contract With Salvage Cost

- To coordinate the supply chain coordination equalize target service level!

$$\frac{p-c}{p-s} = \frac{p-w}{p-w+w-b}$$

$$\Rightarrow b = p - (p-w) \times \frac{p-s}{p-c}$$



p = retail price
s = salvage value
w = wholesale price
c = cost per unit to the supplier

Revenue Sharing vs. Buy-Back

- If comparing between revenue sharing (RS) and buyback contracts (BB), what factors are important to consider?
  - Both are subject to retailer effort distortion
  - RS requires huge auditing effort, BB requires good return process
  - RS requires upfront loss for Supplier; BB requires higher upfront investment from Retailer; so can be affected by which part is more financially constrained
  - Loss-averse people would potentially dislike RS more because of the upfront loss
- Bottom line: designing the right parameters is only the first step, needs a lot of care in the implementation details, otherwise the theoretical benefit remains theoretical and would never be materialized

Supply Chain Contracts Wrap-Up

- With wrong incentives the supply chain can perform sub-optimally (= how to share risk?)
- Risk sharing (incentive alignment) maximizes size of pie (= supply chain coordination)
- Skillful contracting lets us do this while remaining cognizant of incentives
- Many ‘contracts’: must calibrate carefully (there are many feasibility issues)