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Supply Contracts at SkiRetail

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Introduction

John Bergard sat behind his desk staring out of the large glass window in his office in Aspen, Colorado on a cold Tuesday morning. The view of the Rockies was breathtaking. "This is indeed a great place to work," thought John. As he sipped his warm coffee, he began to focus his thoughts on his upcoming meeting on Friday with SkiRetail, an upscale fashion retailer in Aspen.

Bergard had joined Skiekz only a month ago, after graduating from HEC Montréal with a specialization in logistics and supply chains. He was in charge of designing sales as well as purchase contracts for the company's newly opened operations in Aspen. He reported to Mark Bayer, who was the Chief Operating Officer at Skiekz, Aspen.

Friday was a big day for Bergard. He was scheduled to meet with the purchase manager at SkiRetail. The retailer would place an order for Skiekz's ski jackets for the upcoming winter season on Friday. Bergard, accompanied by the head of marketing, had to convince the retailer to buy more of their products. SkiRetail was a well-established retail firm and Bergard knew that he had to back up his arguments with strong numbers if he was to stand a chance of convincing the team at SkiRetail to purchase more of Skiekz's jackets.

Bergard knew that he would need to draw on his five years of supply chain experience with a retail giant in the US as well as on his education in logistics and supply chains. "Well," he thought to himself, "let's take it one step at a time." He prepared to leave for a meeting that was scheduled with the marketing team in ten minutes.

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Skiekz

Skiekz designs, manufactures and distributes stylish ski wear to high-fashion retailers in Switzerland. The company was founded in 2001 in Switzerland by Chris Adler, an avid ski and business enthusiast and a fashion designer by training. Adler's designs were highly regarded for their style as well as their functionality. By 2010, Skiekz was a formidable brand and a leading manufacturer of high-fashion ski wear in Switzerland.

The selling season for Skiekz's products typically began in November and lasted until January. The design process for the subsequent winter season would begin about ten months in advance. Adler would complete the initial designs for the subsequent selling season by March and share them with the manufacturing department. The initial prototypes would then be created and an exhibition would be held to showcase the prototypes to the high-fashion retailers of Switzerland. Adler would incorporate any suggestions provided during the exhibition and finalize the designs. A prototype of the final design would then be sent to all the retailers, along with an invitation to place an order for the quantities they wished to purchase. The retailers would then provide their order quantities based on inputs from their marketing departments by July. Skiekz would then go into production for the different orders received from the retailers by the beginning of August. The manufacturing process, including the sourcing of raw materials, took 75 days. Skiekz would ship all the orders by mid-October.

Skiekz manufactures a variety of ski wear products, including pants, jackets, shells, vests, sweaters and other accessories. Jackets accounted for 78% of its total revenues, sweaters for 12% and the other products for the remaining 10% of the company's revenues (see Appendix 1).

In 2013, Skiekz expanded operations into the United States of America, with a first location in Aspen. Adler sensed a great business opportunity in the expansion, since he was convinced that European fashion products were highly regarded in the United States. The strategy of the company would remain the same. Adler and his team would design the products; Skiekz would manufacture the ski wear products locally and sell the merchandize through upscale high-fashion retail outlets in the region. Skiekz was interested in doing business with a well-established fashion retailer called SkiRetail. It was the norm at Skiekz that the manufacturer would ship products only in batches of 1,000 units. Aspen would be no exception.

11:00 A.M., Skiekz Office, Aspen

John Bergard walked back into his office from the just-concluded meeting with the marketing team. Bergard had asked for specific inputs from the marketing team about forecasts for jackets, as his meeting on Friday was to be centred on the finalization of the strategy for jackets with SkiRetail. Subsequent meetings in the following week were scheduled for a discussion of other Skiekz products.

Bergard reviewed all the information he had thus far. Paul Archer, the head of marketing, had told him that the expected price at which Skiekz could sell to SkiRetail was $200. Archer had also provided him with market intelligence reports containing the historical demand for high-

fashion ski jackets at SkiRetail (see Appendix 2). He had told Bergard that he expected the retailer to sell the jackets for $250 apiece. Bergard had learned from the production team that it would cost Skiekz $140 to produce one unit of the jacket. Additionally, the company would have a fixed cost of $70,000 to cater to the production for the upcoming season.

Bergard knew that it is difficult to predict demand for high-fashion goods. "People either like the design that season or they don't. It's as simple as that," he thought. He knew that SkiRetail did not want to get stuck with too much unsold inventory. SkiRetail would have to sell all the jackets not sold within the season to discount retailers for $60 apiece. SkiRetail had seemed optimistic about the new designs when they had been shown the prototypes and Bergard knew that the retailer would not want to lose out on sales opportunities by placing an order for too small a quantity either. But how could he coax them to buy more? Bergard heard himself say aloud, "First, I'll need to figure out what SkiRetail would consider as the optimal quantity, given what I know."

Bergard had learned from his experience and his supply chain classes that, often, there is a lot of unclaimed value left behind in the supply chain when entities within the supply chain tend to optimize their own individual profits. "I need to calculate the maximum profits that could be drawn from the supply chain, and the best way to calculate this is by considering the supply chain as one vertically integrated unit. That way, I will be able to find the global optimum profit levels for the entire supply chain." He recollected a lecture from one of his classes: "The global optimum profit levels are much higher than the aggregate sum of profits when individual entities in the supply chain tend to maximize their individual profits."

"Once I estimate the optimal order quantity for SkiRetail, I'll be able to figure out how much value is left unclaimed in the supply chain by calculating the global optimum profit levels." Obviously, higher profit levels can be achieved only through more sales, which would mean that SkiRetail would purchase more units than what it believed was the optimal quantity. "This unclaimed value is what I would need to take advantage of, if I need to convince the guys at SkiRetail to buy more than what they think is optimal," Bergard thought.

He pondered a discussion he had had with his professor a few months earlier. He recalled that supply chain contracts were a method to capture the unclaimed value left behind in the supply chain. He had learned that firms were willing to buy more if risks were shared and that supply contracts help firms share risks and potential benefits. Bergard reached for his notes and browsed through them. Finally he opened a page which read:

> There are several types of supply contracts that a manager could enforce to share both potential risks and benefits with suppliers:
>
> 1) **Buy-back contracts**
>
>   In this type of contract, the manufacturer agrees to buy back unsold goods from the retailer for some agreed-upon price higher than the salvage value.
>
> 2) **Revenue-sharing contracts**
>
>   In this type of contract, the manufacturer shares a percentage of the revenues earned by the retailer. In return, the manufacturer reduces the unit price at which the retailer would be required to buy from the manufacturer.

Just as Bergard was finishing reading his notes, Bayer walked into his office and said, "Hi John. How is everything coming along?" Bergard briefed Bayer about all that he had learned. "That makes a lot of sense. But John, let's say we propose the buy-back contract. That would mean that we would have to buy back the entire unsold inventory from SkiRetail. Wouldn't that hurt our profits instead of raising them?" Bergard was quick to respond: "Well Mark, it would also induce SkiRetail to buy more. So you see, we can increase our revenues as well."

"I will have to see the numbers. Can you tell me what buy-back price we would have to offer to SkiRetail to result in increased profits for us? Of course, this scenario has to increase SkiRetail's profits as well. Why else would they consider it otherwise? And as for the revenue-sharing model, what do you think is the optimal price at which we should sell the jackets to SkiRetail? I spoke to Paul this afternoon and he told me that SkiRetail could agree to a revenue–sharing deal of 15% from regular sales. They would be unwilling to share their revenues from discount retailers. Can you brief me on these points by tomorrow? I'd like to know your recommendation as well so that we can finalize our strategy before your meeting with the team at SkiRetail."

"Sounds good!" Bergard responded, "I'll run them by you tomorrow Mark."

"Great!" said Mark. "See you tomorrow then."

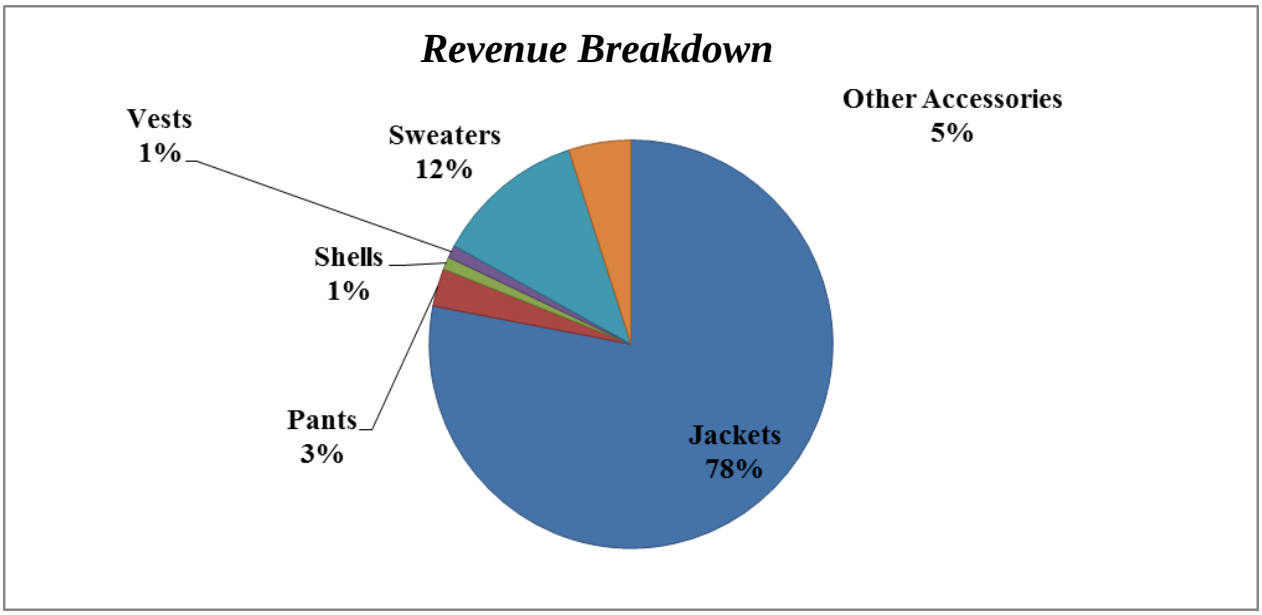
Bergard quickly made a list of the questions he needed to answer for his meeting with Mark the next day:

1. What is my estimate of the quantity of ski jackets that SkiRetail should place an order for?
2. What is the global optimum profit level in this case? In case of a buy-back contract, since we will buy up the unsold inventory from SkiRetail, there would be no additional revenue from third-party discount retailers. However, in the case of the revenue-sharing model, additional revenue would flow into the supply chain from third-party discount retailers. In that case, will the global optimum profit levels remain the same? How should I account for the difference?
3. In the case of a buy-back contract, what is the optimal buy-back price Skiekz should propose?
4. In the case of a revenue-sharing contract, what is the optimal sales price Skiekz should propose, given that SkiRetail is willing to share 15% of its revenues from regular sales?
5. Should I recommend a buy-back contract or a revenue-sharing contract? Why? What are the potential benefits and risks associated with each?

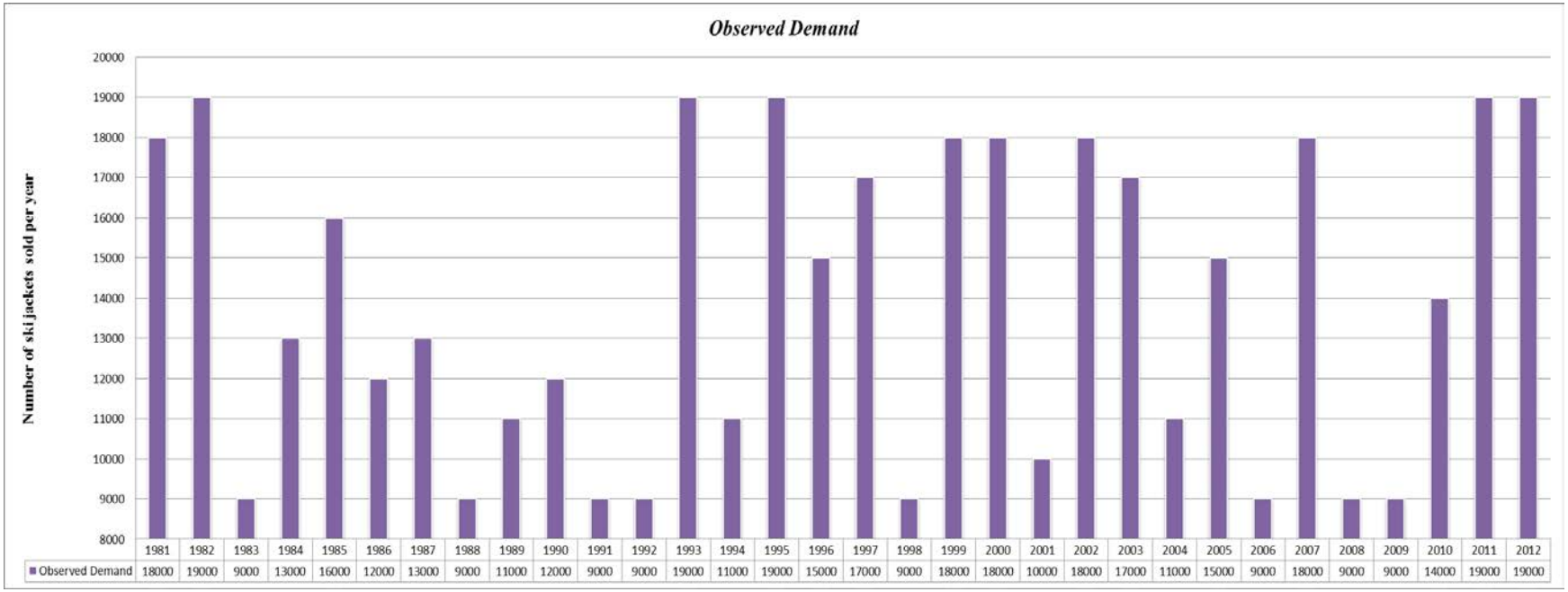
Bergard knew that he had to supplement each of his arguments with concrete data in order to convince Mark and devise an effective contract for SkiRetail.

2014-01-27

Appendix 1
Revenue Breakdown



Appendix 2
Observed Demand



	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Observed Demand	18000	19000	9000	13000	16000	12000	13000	9000	11000	12000	9000	9000	19000	11000	19000	15000	17000	9000	18000	18000	10000	18000	17000	11000	15000	9000	18000	9000	9000	14000	19000	19000

Supply Chain Contracts at SkiRetail

Notes pédagogiques produits par:

SYNOPSIS

Skiekz is a firm based in Switzerland that designs, manufactures and distributes high fashion ski wear products to upscale retailers. It is a well-established brand within Switzerland and has recently started operations in Aspen, Colorado.

John Bergard, in charge of designing sales and purchase contracts, has an upcoming meeting with SkiRetail, a large retail firm in Aspen. He, along with the head of marketing from Skiekz, is slated to meet with the team at SkiRetail to induce the retail firm to buy more of Skiekz's jackets.

The selling season for Skiekz's products is from November to January. The production process for the subsequent season begins with Chris Adler, the founder, finishing the initial designs by March. The manufacturing department would then create prototypes of the design and showcase it in exhibitions to high fashion retailers in the region. After incorporating the suggestions received during the exhibitions, Adler would finalize the design and a final prototype is despatched to retailers inviting them to place their orders. By July, retailers provide their order quantities. Skiekz begins production by August and despatches the orders by mid-October.

Bergard figures out that the best way to incentivize SkiRetail to buy more quantities than what the retailer thinks is optimal for itself, is by sharing its risks. He knows that one method to share potential benefits and risks between firms is through supply contracts.

For this, Bergard begins by trying to estimate the order quantity that SkiRetail would consider optimal. Next, he contemplates on calculating the global optimum profit levels to estimate the total unclaimed value residual in the supply chain if the order quantity that SkiRetail considers optimal is adhered to. He considers the use of either the buy-back contract or the revenue sharing contract in order to capture some of the unclaimed value that would be left behind otherwise. Furthermore, he considers that the global optimal profit levels may be different for the buy-back and revenue sharing scenario since one would have additional revenue flow in to the supply chain from third party discount retailers while the other would not. He ponders what the optimal buy back price should be in case of the buy- back contract and what the optimal sale price should be in case of the revenue sharing contract and their corresponding effects on profits before finalizing on a recommendation on the best strategy for Skiekz.

POSITION IN COURSE

This case is intended for use in a course on supply chain management. This case showcases a basic application of the newsvendor model and introduces the concept of supply chain contracts. It can be used in ***Logistics and Supply chains*** for the MBA program (GOL 535-0702A. HEC Montréal) and either in ***Supply Chain Management: Fundamentals and Trends (6-515-12A)*** for the Global Supply Chain Management program for MSc or in Supply Chain Management (3-525-05A) for the Undergraduate level elective.

SUGGESTED ASSIGNMENT QUESTIONS

1. As Bergard, what is your estimate of the quantity for ski jackets that SkiRetail shall place an order for?
2. What is the global optimum profit level in this case? In case of a buy-back contract, since we will buy up the unsold inventory from SkiRetail, there would be no additional revenue from third party discount retailers. However, in the case of revenue sharing model, additional revenue shall flow into the supply chain from third party discount retailers. Hence, will the global optimum profit levels remain the same in the two scenarios? How should the difference be accounted for?
3. For a buy-back contract what is the optimal buy-back price Skiekz should propose?
4. For a revenue share contract, what is the optimal sales price Skiekz should propose, given that SkiRetail is willing to share 15% of its revenues from regular sales?
5. As Bergard, would you recommend a buy-back contract or a revenue sharing contract? Why? What are the potential benefits and the risks associated with each?

ANALYSIS

Bergard's estimate of the quantity of ski jackets that SkiRetail shall place an order for without the enforcement of any supply contract

SkiRetail would place an order for a quantity that shall be in its best economic interest. This quantity is the ***optimal order quantity*** for SkiRetail, which can be calculated as shown below.

Optimal order quantity

There are a couple of constraints, as listed below, that SkiRetail has to respect while deciding on an order quantity for the ski jackets.

First, the case mentions that Skiekzs ski jackets are high fashion products. A new design of the ski jackets is introduced every season and hence it is difficult to estimate the demand for the jackets accurately in advance. Knowledge of whether the design is accepted or rejected by the

consumers can be known only during the selling season. In essence, an accurate demand for the ski jackets can only be derived from the quantity of sales during the selling season.

Second, there is a long lead time for production. The case mentions that the manufacturing process takes 75 days, while the selling season lasts for about 90 days (November through January). It would not be possible to adopt a strategy of placing an order for a small quantity initially, and then re-ordering based on the success of the product since the manufacturing process takes almost as long as the duration of the selling season itself.

Thus, Ski Retail could end up ordering either less than the demand or more than the demand. If SkiRetail places an order for a quantity less than the demand then it will not be able to re-order for more as mentioned above and thus will lose out on sales opportunities. On the other hand, if it orders for a quantity more than the demand, it will be stuck with unsold inventory. There are significant costs related to excess inventory, since it is given in the case that SkiRetail would be able to sell an unsold jacket it would purchase for $200 to a discount retailer at a mere $60. Thus, for every unsold jacket, SkiRetail would have to incur a loss of $140.

Specifically, the two types of costs involved as observed in the previous paragraph are:

1) Cost of excess inventory
2) Cost of stock out.

The first situation corresponds to placing an order for a quantity that exceeds the demand. The second situation corresponds to placing an order for a quantity that is lesser than the demand.

Summary:	SkiRetails decision of the optimal order quantity shall be subject to the following constraints: 1) The demand for the ski jackets is difficult to estimate accurately in advance. 2) The lead time for production is long. Therefore, it is not possible to reorder. 3) Costs associated with excess inventory 4) Costs associated with stock-outs.

Calculation of the optimal order quantity

The optimal quantity, say Q*, that SkiRetail shall order must be such that it will buy an additional unit only when the expected benefit of selling that unit is higher than the expected cost of having it left over. In essence, for each unit that SkiRetail buys until Q*, the expected benefits of selling are higher than the expected costs associated with left over inventory. And for every unit above quantity Q*, the expected cost of excess inventory is higher than the expected benefits of selling.

Mathematically,

$$Cost(Q,D) = \begin{cases} c_o(Q-D) & \text{if } D < Q \\ c_u(D-Q) & \text{if } D \geq Q \end{cases}$$

Where Q is the quantity ordered and D is the demand.

If p(D) denotes the probability mass function, the estimated cost associated with producing a quantity Q would be all the costs associated with producing Q multiplied by the probability that corresponds to Quantity Q.

That is,

$$ECost(Q) = \sum_{D=0}^{\infty} p(D)Cost(Q,D) = c_o \sum_{D=0}^{Q-1} p(D)(Q-D) + c_u \sum_{D=Q}^{\infty} p(D)(D-Q)$$

The first term in the equation corresponds to the costs associated with excess production while the second term corresponds to stock-out costs. The optimal quantity Q* is the value of the quantity where the expected cost function is flat. In essence, Q* is the quantity at which the expected costs associated with purchasing Q and Q+1 are approximately the same.

$$ECost(Q) \approx ECost(Q+1)$$

Thus, Q* is the smallest value of Q such that,

$$P(Q^*) = \sum_{D=0}^{Q^*} p(D) \geq \frac{c_u}{c_u + c_o}$$

Where c_u is the marginal benefit and c_0 is the marginal cost.

1. From the case, c_u = Selling Price – Purchase Price = \$250 - \$200 = \$60
2. c_0 = Purchase Price – Salvage Value = \$200 - \$60 = \$140
3. The acceptable service level for SkiRetail, $P(Q^*) = c_u \div (c_u + c_0) = 60 \div (60 + 140) =$ **26.32%.**

Appendix 2 in the case showcases observed demand for ski jackets for the period between 1981 and 2012. A frequency table can be constructed from the observed demand data which is as shown in *figure 1* below.

Frequency Table			
Units Sold	Frequency	Probability	Cumulative Probability
9000	8	25.00%	25.00%
10000	1	3.13%	28.13%
11000	3	9.38%	37.50%
12000	3	9.38%	46.88%
13000	1	3.13%	50.00%
14000	1	3.13%	53.13%
15000	2	6.25%	59.38%
16000	1	3.13%	62.50%
17000	2	6.25%	68.75%
18000	5	15.63%	84.38%
19000	5	15.63%	100.00%

Figure 1

The optimal order quantity is the quantity which can cater to at least a service level of 26.32%. From figure 1, we can ascertain the ***optimal order quantity as 10,000 units of ski jackets***.

Based, on the optimal quantity ascertained above, let us now calculate the profits for all the entities in the supply chain.

SkiRetail Profits for an order quantity of 10,000 units of ski jackets

Selling Price	$ 250.00
Purchase Price	$ 200.00
Salvage Value	$ 60.00

Scenario	Demand	Probability	Quantity Ordered	Revenue from Sales	Revenue from discount sales	Cost	Profit	Expected Profit
1	9000	25.00%	10000	$ 2,250,000.00	$ 60,000.00	$ 2,000,000.00	$ 310,000.00	$ 77,500.00
2	10000	3.13%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 15,625.00
3	11000	9.38%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 46,875.00
4	12000	9.38%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 46,875.00
5	13000	3.13%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 15,625.00
6	14000	3.13%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 15,625.00
7	15000	6.25%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 31,250.00
8	16000	3.13%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 15,625.00
9	17000	6.25%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 31,250.00
10	18000	15.63%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 78,125.00
11	19000	15.63%	10000	$ 2,500,000.00	$ -	$ 2,000,000.00	$ 500,000.00	$ 78,125.00
The total expected profit for SkiRetail is								**$ 452,500.00**

The calculations are done as follows:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales:
    a. If the demand < Quantity Ordered, then Revenue from sales = Demand × Selling Price.
    b. Otherwise, Revenue from Sales = Quantity Ordered × Selling Price
3. Revenue from discount sales:
    a. If the Quantity Ordered > demand, then (Demand – Quantity Ordered) × Salvage Value
    b. Otherwise, 0
4. Cost: Quantity Ordered × Purchase Price
5. Profit: (Revenue from sales + Revenue from discount sales) – Cost
6. Expected Profit: Profit × Probability of the scenario
7. Total Expected Profit: Sum of all the expected profits for each scenario

Skiekz Profits for an order quantity of 10,000 units of ski jackets

Selling Price	$ 200.00
Variable Cost	$ 140.00
Fixed Cost	$ 70,000.00

Scenario	Demand	Probability	Quantity Ordered	Revenue from Sales	Variable cost of production	Fixed cost of production	Profit	Expected Profit
1	9000	25.00%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 132,500.00
2	10000	3.13%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 16,562.50
3	11000	9.38%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 49,687.50
4	12000	9.38%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 49,687.50
5	13000	3.13%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 16,562.50
6	14000	3.13%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 16,562.50
7	15000	6.25%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 33,125.00
8	16000	3.13%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 16,562.50
9	17000	6.25%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 33,125.00
10	18000	15.63%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 82,812.50
11	19000	15.63%	10000	$ 2,000,000.00	$ 1,400,000.00	$ 70,000.00	$ 530,000.00	$ 82,812.50
The total expected profit for Skiekz is								**$ 530,000.00**

The calculations are done as follows:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales: Order Quantity × Selling Price
3. Variable cost of production: Order Quantity × Variable Cost
4. Profit: Revenue from sales – (Variable cost of production + Fixed cost of production)
5. Expected Profit: Profit × Probability of the scenario
6. Total Expected Profit: Sum of all the expected profits for each scenario

Supply chain profits for an order quantity of 10,000 units of ski jackets

The total supply chain profits for an order quantity of 10,000 units of ski jackets in an uncoordinated supply chain scenario would be: = $452,500 + $530,000 = ***$982,500***

Summary:

In an uncoordinated supply chain scenario, that is, a scenario in which SkiRetail would deduce an optimal order quantity independently and without any coordination with Skiekz, the following is observed.

1. *Service Level: 26.32%*
2. *Optimal Order Quantity: 10,000 units*
3. *SkiRetail Profits: $452,500*
4. *Skiekz Profits: $530,000*
5. *Total supply chain Profits: $982,500*

Global optimization

A global optimization strategy is one which caters to the best interest of the entire supply chain rather than to the interests of individual entities in the supply chain. To assess whether a global optimization strategy is indeed better than uncoordinated supply chain strategies(strategies in the best interest of individual entities in the supply chain), the supply chain provided in the case is considered as one entity comprising of both Skiekz and SkiRetail as if they were vertically integrated and hence no internal transactions are considered.

The scenario is depicted in the following diagram.

As mentioned in the case, there are two possible global optimum strategies. ***One***, is with the consideration of a salvage value and ***two***, is without the consideration of a salvage value. This is important because, in the first case additional revenue from discount sale shall be available to the supply chain consisting of SkiRetail and Skiekz and hence is relevant for a revenue share model. The second case pertains to a buy-back contract model, where there shall be ***no*** additional revenue available from a third party to the combined entity of SkiRetail and Skiekz, since in this scenario Skiekz would buy back the entire unsold inventory from SkiRetail and not a third party discount retailer.

Global Optimization without salvage value: Buy-Back Contract

Sale Price	$ 250.00
Production cost (variable)	$ 140.00
Fixed cost	$ 70,000.00
Salvage Value	$ -
c_u (Marginal Benefit)	$ 110.00
c_o (Marginal Cost)	$ 140.00

1. c_u = Sale Price – Production Cost = $250 - $140 = $110
2. c_0 = Purchase Price – Salvage Value = $140 - $0 = $140
3. Thus the acceptable service level, $P(Q^*) = c_u \div (c_u + c_0) = 110 \div (110 + 140) =$ **44%.**

For the service level of 44% we can ascertain the ***optimal order quantity*** from figure 1, ***as 12,000 units of ski jackets***.

Supply chain profits for an order quantity of 12,000 units of ski jackets

Scenario	Demand	Probability	Quantity Ordered	Revenue from Sales	Variable cost of production	Fixed cost of production	Profit	Expected Profit
1	9000	25.00%	12000	$ 2,250,000.00	$ 1,680,000.00	$ 70,000.00	$ 500,000.00	$ 125,000.00
2	10000	3.13%	12000	$ 2,500,000.00	$ 1,680,000.00	$ 70,000.00	$ 750,000.00	$ 23,437.50
3	11000	9.38%	12000	$ 2,750,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,000,000.00	$ 93,750.00
4	12000	9.38%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 117,187.50
5	13000	3.13%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 39,062.50
6	14000	3.13%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 39,062.50
7	15000	6.25%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 78,125.00
8	16000	3.13%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 39,062.50
9	17000	6.25%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 78,125.00
10	18000	15.63%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 195,312.50
11	19000	15.63%	12000	$ 3,000,000.00	$ 1,680,000.00	$ 70,000.00	$ 1,250,000.00	$ 195,312.50
The total expected profit for the supply chain is								***$1,023,437.50***

The calculations are done as follows:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales:
    a. If Quantity Ordered > Demand, then Revenue from sales = Demand × Selling Price
    b. Otherwise, Revenue from sales = Quantity Ordered × Selling Price
3. Variable cost of production: Order Quantity × Production cost (variable)
4. Profit: Revenue from sales – (Variable cost of production + Fixed cost of production)
5. Expected Profit: Profit × Probability of the scenario
6. Total Expected Profit: Sum of all the expected profits for each scenario

The expected profit for the supply chain for the global optimum levels without the consideration of salvage value is ***$1,023,437.50***

Global Optimization with salvage value: Revenue share Contract

As before, we shall consider the entire supply chain as one entity as if SkiRetail and Skiekz are vertically integrated. The only difference is that a salvage value of $60 shall now be considered.

Sale Price	$ 250.00
Production cost (variable)	$ 140.00
Fixed cost	$ 70,000.00
Salvage Value	$ 60.00
c_u (Marginal Benefit)	$ 110.00
c_o (Marginal Cost)	$ 80.00

1. c_u = Sale Price – Production Cost = $250 - $140 = $110
2. c_0 = Purchase Price – Salvage Value = $140 - $60 = $80
3. Thus the acceptable service level, $P(Q^*) = c_u \div (c_u + c_0) = 110 \div (110 + 80) =$ **57.89%.**

For the service level of 57.89% we can ascertain the ***optimal order quantity*** from figure 1, ***as 15,000 units of ski jackets***.

Supply chain profits for an order quantity of 15,000 units of ski jackets

Scenario	Demand	Probability	Quantity Ordered	Revenue from Sales	Revenue from Sale to discount retailers	Variable cost of production	Fixed cost of production	Profit	Expected Profit
1	9000	25.00%	15000	$ 2,250,000.00	$ 360,000.00	$ 2,100,000.00	$ 70,000.00	$ 440,000.00	$ 110,000.00
2	10000	3.13%	15000	$ 2,500,000.00	$ 300,000.00	$ 2,100,000.00	$ 70,000.00	$ 630,000.00	$ 19,687.50
3	11000	9.38%	15000	$ 2,750,000.00	$ 240,000.00	$ 2,100,000.00	$ 70,000.00	$ 820,000.00	$ 76,875.00
4	12000	9.38%	15000	$ 3,000,000.00	$ 180,000.00	$ 2,100,000.00	$ 70,000.00	$ 1,010,000.00	$ 94,687.50
5	13000	3.13%	15000	$ 3,250,000.00	$ 120,000.00	$ 2,100,000.00	$ 70,000.00	$ 1,200,000.00	$ 37,500.00
6	14000	3.13%	15000	$ 3,500,000.00	$ 60,000.00	$ 2,100,000.00	$ 70,000.00	$ 1,390,000.00	$ 43,437.50
7	15000	6.25%	15000	$ 3,750,000.00	$ -	$ 2,100,000.00	$ 70,000.00	$ 1,580,000.00	$ 98,750.00
8	16000	3.13%	15000	$ 3,750,000.00	$ -	$ 2,100,000.00	$ 70,000.00	$ 1,580,000.00	$ 49,375.00
9	17000	6.25%	15000	$ 3,750,000.00	$ -	$ 2,100,000.00	$ 70,000.00	$ 1,580,000.00	$ 98,750.00
10	18000	15.63%	15000	$ 3,750,000.00	$ -	$ 2,100,000.00	$ 70,000.00	$ 1,580,000.00	$ 246,875.00
11	19000	15.63%	15000	$ 3,750,000.00	$ -	$ 2,100,000.00	$ 70,000.00	$ 1,580,000.00	$ 246,875.00
The total expected profit for the supply chain is									**$ 1,122,812.50**

The calculations are done as follows:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales:
    a. If Quantity Ordered > Demand, then Revenue from sales = Demand × Selling Price
    b. Otherwise, Revenue from sales = Quantity Ordered × Selling Price
3. Revenue from sale to discount retailers:
    a. If Quantity Ordered > Demand, then Revenue from sale to discount retailers = (Quantity Ordered – Demand) × Salvage Value
    b. Otherwise, Revenue from sale to discount retailers = $0
4. Variable cost of production: Order Quantity × Production cost (variable)
5. Profit: Revenue from sales – (Variable cost of production + Fixed cost of production)
6. Expected Profit: Profit × Probability of the scenario
7. Total Expected Profit: Sum of all the expected profits for each scenario

The expected profit for the supply chain for the global optimum levels without the consideration of salvage value is ***$1,122,812.50***

Summary:

Scenario	Expected Supply Chain Profits	Optimal Quantity
Uncoordinated	**$982,500**	**10,000**
Global Optimum without salvage value	**$1,023,437.50**	**12,000**
Global Optimum with salvage value	**$1,122,812.50**	**15,000**

Thus, there is clearly unclaimed value left behind in the supply chain in an uncoordinated supply chain scenario. It can be observed here that the global

optimum profit levels with the consideration of a salvage value are higher than that without the consideration of a salvage value. As explained earlier, this is due to the additional revenue received from a third party (discount retailer) which would not be available in case of a buy-back contract.

Additionally, it can also be observed here that higher profit levels correspond to higher order quantities. This is logical since higher profits can be achieved through higher levels of sales.

So the question now is that can global optimum profit levels be achieved through supply chain coordination? The answer is ***yes***. Skiekz can indeed incentivize SkiRetail to purchase more units of ski jackets by way of implementing effective supply contracts.

Supply contracts

As can be seen from above, profit levels of up to $1,122,812.50 could be potentially extracted from the supply chain. If the retail firm were to decide on an optimal quantity of purchase (and hence production) on the basis of maximizing its own profit there is a residual unclaimed value in the supply chain. Furthermore, it is also evident that higher profit levels relate to higher order quantities.

The primary reason for SkiRetail to place an order for a quantity lesser than that required to achieve globally optimized profit levels in an uncoordinated scenario is that SkiRetail assumes all of the financial risk of either a stock out or excess inventory while Skiekz assumes no risk at all. If Skiekz were to be willing to share some of the financial risks (and potential benefits) with SkiRetail, there will be a clear incentive for SkiRetail to increase the order quantity. The sharing of risks and the potential benefits can be induced with the use of supply contracts.

Summary:

Supply contracts help firms achieve global optimization, by allowing suppliers and buyers to share risk and potential benefits.

Buy-back contract:

Under this contract, Skiekz shall agree to buy back unsold inventory from SkiRetail for a price higher than the salvage value that the retailer would get otherwise from discount retailers. The prospect of buying back unsold inventory may seem to result in a reduction of Skiekzs profits as feared by Bergard's boss due to the introduction of additional costs. However, it must be noted that doing so would result in sharing some of SkiRetails risk, which would in turn encourage the retailer to purchase a higher quantity than in an uncoordinated supply chain scenario. The higher quantity purchased shall result in higher revenues for Skiekz. Thus, although the buy-back contract shall introduce additional costs, Skiekz shall earn higher revenues. The key of course is to find the optimal buy-back price such that the expected additional revenues are greater than the additional costs that may have to be incurred, thus resulting in increased profits for Skiekz. In

fact, enforcing a buy-back contract shall help ***both*** firms achieve better profit levels as compared to the uncoordinated supply chain scenario.

To calculate the optimal buy-back price that Skiekz should offer, it is important to take note of the range of possible values. ***First***, the buy-back price has to be greater than the salvage value that SkiRetail would get by selling off the unsold inventory to discount retailers. If not, there is no economic reason for SkiRetail to consider the offer from Skiekz. ***Second***, the buy-back price cannot exceed the variable cost of production of the ski jacket. Otherwise, Skiekz would incur a potential loss on every unit that it buys-back from SkiRetail since it would pay a price higher than its cost of producing the ski jacket.

Range for Buy-Back price	
Minimum	**$ 60.00**
Maximum	**$ 140.00**

To calculate the optimal buy-back price, the profits of each firm are calculated for all prices in the prescribed range of the buy-back price as mentioned above. The profit functions for each firm are plotted against the buy-back price and are as shown in *figure 2* below.

The X-Axis in figure 2 represents the buy-back price. The Y-Axis represents the profits.

As can be seen from figure 2, the profits for SkiRetail increases with an increasing buy-back price essentially because the firm would earn higher revenues on the unsold inventory at higher buy-back prices at no additional cost.

The profit function for Skiekz is a step function. The steps correspond to points where the order quantity changes. The expected profits for Skiekz increases at each step where the order quantity changes till the optimal quantity is reached beyond which the expected profits decrease at each step. Furthermore, within the same order quantity the expected profits decrease steadily with an increase in the buy-back price. This can be explained by the fact that within the same order quantity, increasing buy-back prices for Skiekz would result in increased costs with its revenues remaining constant.

The total profit function represented by the green line is the sum of the profits of SkiRetail and Skiekz. As can be seen, the total supply chain profits increase at each step corresponded by a change in order quantities until the optimal order quantity is reached beyond which the overall profits decrease. Furthermore, the profits remain unchanged within a given order quantity irrespective of the buy-back price.

The maximum expected total profit for the supply chain by enforcing a buy-back contract is found to be $1,023,437.50. This corresponds to an optimal order quantity of 12,000 units of ski jackets. It can be recollected that these are essentially the same values as the ones corresponding to the global optimum profit levels without the consideration of a salvage value.

As explained earlier, since Skiekz would buy back the entire unsold inventory, there would be no additional revenue that shall flow into the supply chain from any third party such as discount

retailers. Thus it is apt to compare the profit levels that could be achieved with the buy-back contract with the global optimum profit levels calculated without the consideration of a salvage value.

Appendix 1 shows the profits of each firm for the different buy back prices. The cells highlighted in yellow indicate buy-back prices at which both SkiRetail and Skiekz would achieve higher profits than what they would achieve in an uncoordinated supply chain scenario. Appendix 2 details the calculations used to arrive at these values.

As seen earlier, the profits for both the firms in an uncoordinated supply chain scenario are as follows:

SkiRetail Profits: $452,500

Skiekz Profits: $530,000

From Appendix 1, buy-back prices between $117 and $132 represent scenarios where the profits for both the firms are greater than what they would achieve without any coordination of the supply chain. Essentially, this forms the range of negotiation that could be held between both firms to claim the additional profits introduced by the buy-back contract.

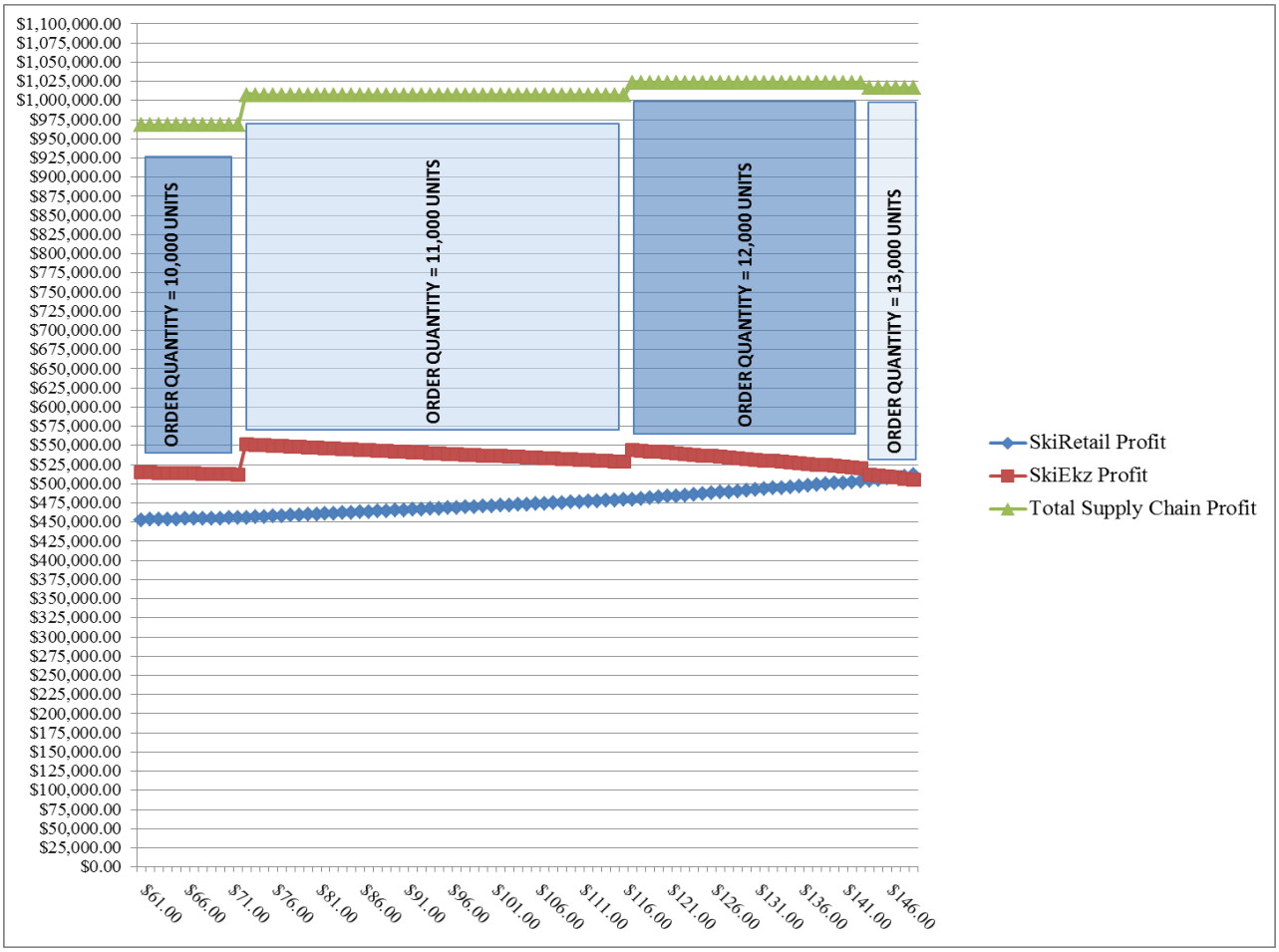


Figure 2

Buy Back Price	Optimal Order Quantity	SkiRetail Expected Profits	Skiekz Expected Profit	Total Supply Chain Profit
$ 117.00	12000	$ 479,468.75	$ 543,968.75	$ 1,023,437.50
$ 118.00	12000	$ 480,375.00	$ 543,062.50	$ 1,023,437.50
$ 119.00	12000	$ 481,281.25	$ 542,156.25	$ 1,023,437.50
$ 120.00	12000	$ 482,187.50	$ 541,250.00	$ 1,023,437.50
$ 121.00	12000	$ 483,093.75	$ 540,343.75	$ 1,023,437.50
$ 122.00	12000	$ 484,000.00	$ 539,437.50	$ 1,023,437.50
$ 123.00	12000	$ 484,906.25	$ 538,531.25	$ 1,023,437.50
$ 124.00	12000	$ 485,812.50	$ 537,625.00	$ 1,023,437.50
$ 125.00	12000	$ 486,718.75	$ 536,718.75	$ 1,023,437.50
$ 126.00	12000	$ 487,625.00	$ 535,812.50	$ 1,023,437.50
$ 127.00	12000	$ 488,531.25	$ 534,906.25	$ 1,023,437.50
$ 128.00	12000	$ 489,437.50	$ 534,000.00	$ 1,023,437.50
$ 129.00	12000	$ 490,343.75	$ 533,093.75	$ 1,023,437.50
$ 130.00	12000	$ 491,250.00	$ 532,187.50	$ 1,023,437.50
$ 131.00	12000	$ 492,156.25	$ 531,281.25	$ 1,023,437.50
$ 132.00	12000	$ 493,062.50	$ 530,375.00	$ 1,023,437.50

Thus, by implementing a buy-back contract and thereby sharing some of the financial risks of SkiRetail, Skiekz can incentivize the retailer to place an order for a higher quantity than in an uncoordinated supply chain. This situation clearly leads to higher profits for both firms in the supply chain.

Although a buy-back contract is clearly more advantageous than having no contract at all, there are constraints that may limit its effective implementation.

First, this contract requires Skiekz to have in place an effective reverse logistics system to receive the unsold inventory from SkiRetail. This increases the cost of logistics which is not accounted in the profit calculation for Skiekz.

Second, the retail firm shall have a higher incentive to push for the sales of competing products for which it does not have a similar contract in place. This is essentially because the implementation of a contract such as the buy-back reduces the risks for SkiRetail. Hence, SkiRetail shall push more aggressively, the competing products for which the risks are much higher.

Third, it is assumed here that the demand forecasts are shared transparently between Skiekz and SkiRetail. However, in reality, SkiRetail can be expected to share inflated forecasts. Since the decision makers are often reluctant to share private information regarding cost and demand, supply chain co-ordination is difficult to achieve with the implementation of a buy-back contract since this type of contract does not account for information asymmetry.

Summary:	*1. A buy-back contract helps in coordination and leads to higher profit opportunities for both the firms in the supply chain.*

2. *There exists a range within which an optimal buy back price lies. The minimum corresponds to the salvage value and the maximum to the variable production cost.*
3. *The profits for SkiRetail increase with an increase in the buy-back price.*
4. *The profits for Skiekz follow a step function. The profit increases with an increase in the order quantity until the optimum order quantity is reached beyond which it decreases with an increase in the order quantity. Furthermore, the profits decrease constantly for a given order quantity with an increase in the buy-back price.*
5. *The total profits for the supply chain also follow a step function. The profit increases with an increase in the order quantity until the optimum order quantity is reached beyond which it decreases with an increase in the order quantity. Furthermore, the profits remain constant for a given order quantity irrespective of the buy-back price.*
6. *The highest profits that could be achieved correspond to the global optimum profit levels without the consideration of a salvage value*
7. *There exist a range of buy back prices for which the profits of both firms are higher than what they could achieve with no coordination.*

Constraints in implementing a buy-back contract

1. *Additional reverse logistics cost*
2. *The tendency of the retailer to push products for which the risks are higher*
3. *Information asymmetry*

Revenue sharing contract:

Under this contract, Skiekz shall agree to reduce the unit price at which SkiRetail shall buy the ski jacket in return for a share of a percentage of the revenues earned by SkiRetail. As given in the case, SkiRetail could be convinced to share 15% of its revenues in return for a purchase price that is lesser than what Skiekz would offer in an uncoordinated supply chain scenario.

The prospect of sharing revenue with Skiekz may seem to result in a reduction of SkiRetails profits. However, it must be noted that these additional costs induced by sharing a part of the revenue can be offset by the reduction in the price at which SkiRetail would purchase the jackets. Here again, the key is to find the optimal sale price for a revenue share model of 85%-15% between SkiRetail and Skiekz such that ***both*** firms achieve better profit levels as compared to the uncoordinated supply chain scenario.

The optimal sale price that Skiekz should offer, for the given revenue share percentage of 15%, shall lie within a specific range of possible values. ***First***, the sale price has to be lesser than what Skiekz would otherwise offer in a scenario without a revenue share. If not, there is no economic reason for SkiRetail to consider the offer from Skiekz. ***Second***, the sale price cannot be lesser

than the variable cost of production of the ski jacket. Otherwise, Skiekz would incur a potential loss on every unit that it sells to SkiRetail.

Range for reduced sale price for Skiekz	
Minimum	$ 140.00
Maximum	$ 200.00

To calculate the optimal sale price for a revenue share of 15%, the profits of each firm are calculated for all prices in the prescribed range of the sale price as mentioned above. The profit function for each firm is plotted against various Skiekz sales prices and is as shown in *figure 3* below.

The X-Axis in figure 3 represents the sale price of Skiekz (or the purchase price of SkiRetail). The Y-Axis represents the profits.

From figure 3, it can be seen that the profits for SkiRetail decreases with an increase in the purchase price (sale price of Skiekz). Specifically, there is a linear decrease in SkiRetail's profits within the same order quantity and changes as a step function at points where the order quantity changes. The first phenomenon is due to the fact the costs for SkiRetail increase with an increase in the purchase price although its revenues remain constant within the same order quantity. The second phenomenon of the step variation is determined by the relative difference between the variation in revenues and the variation in costs due to decreasing order quantities.

The profits for Skiekz increase with an increase in its sale price. It can be observed that, there is a linear increase in profits with increasing values of sale prices within the same order quantity, but changes as a step function at points where the order quantity changes. The first phenomenon is due to the increase in revenues for Skiekz with an increase in its sale price although its costs remain constant within the same order quantity. The second phenomenon of the step variation is due to the impact of the relative difference between the variations in its revenues and costs due to decreasing order quantities.

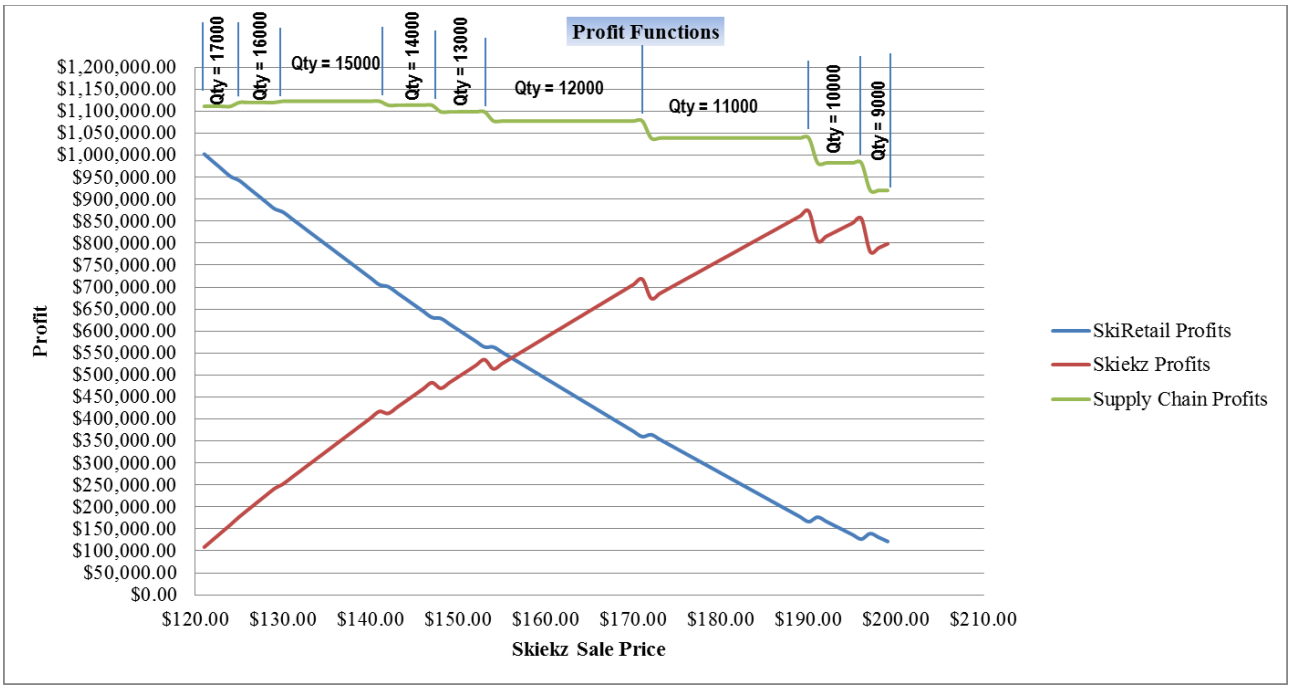


Figure 3

The supply chain profit function represented by the green line is the sum of the profits for SkiRetail and Skiekz. It can be seen that the total supply chain profit attains a maximum of $1,122,812.50 for an order quantity of 15,000 units of ski jackets and decreases either with an increase or decrease of the order quantity around 15,000 units of ski jackets. Furthermore, the total supply chain profits remain constant within any given order quantity. Thus, it can be inferred that 15,000 units of ski jackets is the optimal order quantity that yields the highest supply chain profits. It can be recollected that these values correspond to the global optimum profit levels calculated with the consideration of a salvage value.

Appendix 3 shows the profits of each firm for different Skiekz sale prices. The cells highlighted in yellow indicate Skiekz sale prices at which both SkiRetail and Skiekz would achieve higher profits than what they would have in an uncoordinated supply chain scenario. Appendix 4 details the calculations used to arrive at these values. ***It must be noted here that SkiRetail would share 15% of the revenues earned on regular sales and not on discount sales.***

As seen earlier, the profits for both the firms in an uncoordinated supply chain scenario are as follows:

SkiRetail Profits: $452,500

Skiekz Profits: $530,000

From Appendix 3, Skiekz sale price of $153 and prices between $156 and $162 represent scenarios where the profits for both the firms are greater than what they would achieve without any coordination of the supply chain, even though these price points do not result in global

optimum profit levels. Essentially, this forms the range of negotiation that could be held between both firms to claim the additional profits introduced by the revenue share contract.

SkiEkz Sale Price	Marginal Benefit	Marginal Cost	Service Level	Optimal Quantity	SkiRetail Expected Profits	Skiekz Expected Profit	Total Supply Chain Profit
$ 153.00	$ 82.45	$ 93.00	46.99%	13000	$ 563,812.50	$534,937.50	$1,098,750.00
$ 156.00	$ 79.90	$ 96.00	45.42%	12000	$ 539,796.88	$538,015.63	$1,077,812.50
$ 157.00	$ 79.05	$ 97.00	44.90%	12000	$ 527,796.88	$550,015.63	$1,077,812.50
$ 158.00	$ 78.20	$ 98.00	44.38%	12000	$ 515,796.88	$562,015.63	$1,077,812.50
$ 159.00	$ 77.35	$ 99.00	43.86%	12000	$ 503,796.88	$574,015.63	$1,077,812.50
$ 160.00	$ 76.50	$ 100.00	43.34%	12000	$ 491,796.88	$586,015.63	$1,077,812.50
$ 161.00	$ 75.65	$ 101.00	42.82%	12000	$ 479,796.88	$598,015.63	$1,077,812.50
$ 162.00	$ 74.80	$ 102.00	42.31%	12000	$ 467,796.88	$610,015.63	$1,077,812.50

Thus, a revenue sharing shall also result in Skiekz sharing some of the financial risks of SkiRetail. Hence, by doing so, Skiekz can incentivize the retailer to place an order for a higher quantity than in an uncoordinated supply chain. This situation too leads to higher profits for both firms in the supply chain.

However, like the buy-back contract, a revenue sharing contract is prone to certain implementation constraints as discussed below.

First, this contract increases the administrative costs for Skiekz since it requires a constant monitoring of the buyer's revenue for the product in question, which are not accounted for in the profit calculations for Skiekz.

Second, the retail firm shall have a higher incentive to push for the sales of competing products for which the profit margins shall be higher.

Third, like in the case of a buy-back contract, it is assumed here that the demand forecasts are shared transparently between Skiekz and SkiRetail. Decision makers are reluctant to share private information regarding cost and demand, hence, supply chain co-ordination is difficult to achieve with the implementation of a revenue sharing contract since this too does not account for information asymmetry.

Summary:

1. *A revenue share contract helps in supply chain coordination and leads to higher profit opportunities for both the firms in the supply chain.*
2. *There exists a range within which an optimal Skiekz sale price lies. The minimum corresponds to the variable production cost for Skiekz and the maximum value corresponds to the sale price that Skiekz would offer without a revenue share.*
3. *The profits for SkiRetail decreases with an increase in the purchase price (sale price of Skiekz). There is a linear decrease in SkiRetail's profits within the same order quantity and changes as a step function at points where the order quantity changes.*
4. *The profits for Skiekz increase with an increase in its sale price. Profits increase linearly with increasing values of sale prices within the same order*

quantity, but follow as a step function at points where the order quantity changes.

5. *The total profits for the supply chain also follow a step function. The profit increases with an increase in the order quantity until the optimum order quantity is reached beyond which it decreases with an increase in the order quantity. Furthermore, the profits remain constant for a given order quantity irrespective of Sliekz sale price.*
6. *The highest profits that could be achieved correspond to the global optimum profit levels with the consideration of a salvage value*
7. *There exists a range of Skiekz sale prices, or, SkiRetail purchase prices for which the profits of both firms are higher than what they could achieve with no coordination for a revenue share of 85%-15% between SkiRetail and Skiekz*
8. *The revenue share is only on the revenues earned on regular sales and not on discount sales*

Constraints in implementing a revenue share contract

1. *Additional administrative costs*
2. *The tendency of the retailer to push competing products for which the profit margins are higher (those that do not have a revenue share)*
3. *Information asymmetry*

Recommendation

Since the highest expected profit for Skiekz in a revenue sharing contract can be $625,937.50 as compared to $543,968.75 with a buy-back contract, the revenue sharing contract seems to be a better choice for Bergard and team. However, due consideration has to be given to the additional costs that each of these contracts introduce. Reverse logistics costs in case of buy-back and administrative costs in case of revenue sharing has to be accounted for in the expected profits and a suitable decision has to be made only after accounting for these additional costs. Furthermore, there are many prices that yield higher profits for both the firms under both contracts. The finalization of a price would depend upon negotiations between the two firms.

TEACHING APPROACH

This case introduces the concepts of newsvendor model and supply contracts. The first part presents the reader with a basic application of the newsvendor model to determine the optimal order quantity for a high fashion ski jacket which is manufactured well in advance of the selling season. Furthermore, the case deals with the scenario where the product can be ordered only once for the forthcoming selling season.

The second part introduces the notion of global optimization of a supply chain and its benefits. The idea of supply chain contracts to achieve global optimum profit levels is explored. The reader is then familiarized with two supply chain contracts viz. buy-back and revenue sharing and the associated potential benefits and risks.

The session, lasting between 60 to 90 minutes, can begin by discussing the difficulties in estimating demand for high fashion goods. The discussion can then turn to calculating the optimal order quantity in a scenario such as the one mentioned in the case. The profit levels for each entity in the supply chain can be calculated next for the order quantity calculated in the previous step, following which the overall supply chain profits can be calculated.

The instructor can then lead the discussion onto global optimization and can have the class calculate the profit levels that the supply chain as a whole could achieve if it were to be vertically integrated. Next, the instructor could lead a discussion on the difference between the global optimum profit levels with and without the consideration of a salvage value. The discussion can then be moved to supply contracts as a method to capture the residual unclaimed value in the supply chain and to attain global optimum profit levels.

An introduction to buy-back and revenue sharing contracts can be made. The profits that each entity in the supply chain could achieve for both contract types can be calculated for different buy-back prices in the buy-back contract and Skiekz sale prices in the revenue sharing contract to determine the optimal set of prices that Bergard could use for his negotiations with SkiRetail. Next, the instructor could have the members of the class present their recommendations and finally discuss the implementation constraints for each of the above mentioned contracts. The instructor could wrap the discussion by discussing other types of supply chain contracts using the background reading (book chapter).

REFERENCES

https://www.clamshellbeachpress.com/downloads/newsvendor_problem.pdf

Chapter 4 – Designing and managing the supply chain. D. Simchi-Levi, P. Kaminsky and E. Simchi-Levi, McGraw-Hill/Irwin, 3rd edition, 2007.

APPENDICES

Appendix 1

Scenario	Buy Back Price	Marginal Cost	Service Level	Optimal Order Quantity	SkiRetail Expected Profits	Skiekz Expected Profit	Total Supply Chain Profit
1	$ 61.00	$ 139.00	26.46%	10000	$452,750.00	$ 514,750.00	$ 967,500.00
2	$ 62.00	$ 138.00	26.60%	10000	$453,000.00	$ 514,500.00	$ 967,500.00
3	$ 63.00	$ 137.00	26.74%	10000	$453,250.00	$ 514,250.00	$ 967,500.00
4	$ 64.00	$ 136.00	26.88%	10000	$453,500.00	$ 514,000.00	$ 967,500.00
5	$ 65.00	$ 135.00	27.03%	10000	$453,750.00	$ 513,750.00	$ 967,500.00
6	$ 66.00	$ 134.00	27.17%	10000	$454,000.00	$ 513,500.00	$ 967,500.00
7	$ 67.00	$ 133.00	27.32%	10000	$454,250.00	$ 513,250.00	$ 967,500.00
8	$ 68.00	$ 132.00	27.47%	10000	$454,500.00	$ 513,000.00	$ 967,500.00
9	$ 69.00	$ 131.00	27.62%	10000	$454,750.00	$ 512,750.00	$ 967,500.00
10	$ 70.00	$ 130.00	27.78%	10000	$455,000.00	$ 512,500.00	$ 967,500.00
11	$ 71.00	$ 129.00	27.93%	10000	$455,250.00	$ 512,250.00	$ 967,500.00
12	$ 72.00	$ 128.00	28.09%	10000	$455,500.00	$ 512,000.00	$ 967,500.00
13	$ 73.00	$ 127.00	28.25%	11000	$455,968.75	$ 551,218.75	$ 1,007,187.50
14	$ 74.00	$ 126.00	28.41%	11000	$456,500.00	$ 550,687.50	$ 1,007,187.50
15	$ 75.00	$ 125.00	28.57%	11000	$457,031.25	$ 550,156.25	$ 1,007,187.50
16	$ 76.00	$ 124.00	28.74%	11000	$457,562.50	$ 549,625.00	$ 1,007,187.50
17	$ 77.00	$ 123.00	28.90%	11000	$458,093.75	$ 549,093.75	$ 1,007,187.50
18	$ 78.00	$ 122.00	29.07%	11000	$458,625.00	$ 548,562.50	$ 1,007,187.50
19	$ 79.00	$ 121.00	29.24%	11000	$459,156.25	$ 548,031.25	$ 1,007,187.50
20	$ 80.00	$ 120.00	29.41%	11000	$459,687.50	$ 547,500.00	$ 1,007,187.50
21	$ 81.00	$ 119.00	29.59%	11000	$460,218.75	$ 546,968.75	$ 1,007,187.50
22	$ 82.00	$ 118.00	29.76%	11000	$460,750.00	$ 546,437.50	$ 1,007,187.50
23	$ 83.00	$ 117.00	29.94%	11000	$461,281.25	$ 545,906.25	$ 1,007,187.50
24	$ 84.00	$ 116.00	30.12%	11000	$461,812.50	$ 545,375.00	$ 1,007,187.50
25	$ 85.00	$ 115.00	30.30%	11000	$462,343.75	$ 544,843.75	$ 1,007,187.50
26	$ 86.00	$ 114.00	30.49%	11000	$462,875.00	$ 544,312.50	$ 1,007,187.50
27	$ 87.00	$ 113.00	30.67%	11000	$463,406.25	$ 543,781.25	$ 1,007,187.50
28	$ 88.00	$ 112.00	30.86%	11000	$463,937.50	$ 543,250.00	$ 1,007,187.50
29	$ 89.00	$ 111.00	31.06%	11000	$464,468.75	$ 542,718.75	$ 1,007,187.50
30	$ 90.00	$ 110.00	31.25%	11000	$465,000.00	$ 542,187.50	$ 1,007,187.50
31	$ 91.00	$ 109.00	31.45%	11000	$465,531.25	$ 541,656.25	$ 1,007,187.50
32	$ 92.00	$ 108.00	31.65%	11000	$466,062.50	$ 541,125.00	$ 1,007,187.50
33	$ 93.00	$ 107.00	31.85%	11000	$466,593.75	$ 540,593.75	$ 1,007,187.50
34	$ 94.00	$ 106.00	32.05%	11000	$467,125.00	$ 540,062.50	$ 1,007,187.50
35	$ 95.00	$ 105.00	32.26%	11000	$467,656.25	$ 539,531.25	$ 1,007,187.50
36	$ 96.00	$ 104.00	32.47%	11000	$468,187.50	$ 539,000.00	$ 1,007,187.50
37	$ 97.00	$ 103.00	32.68%	11000	$468,718.75	$ 538,468.75	$ 1,007,187.50
38	$ 98.00	$ 102.00	32.89%	11000	$469,250.00	$ 537,937.50	$ 1,007,187.50
39	$ 99.00	$ 101.00	33.11%	11000	$469,781.25	$ 537,406.25	$ 1,007,187.50
40	$ 100.00	$ 100.00	33.33%	11000	$470,312.50	$ 536,875.00	$ 1,007,187.50
41	$ 101.00	$ 99.00	33.56%	11000	$470,843.75	$ 536,343.75	$ 1,007,187.50
42	$ 102.00	$ 98.00	33.78%	11000	$471,375.00	$ 535,812.50	$ 1,007,187.50
43	$ 103.00	$ 97.00	34.01%	11000	$471,906.25	$ 535,281.25	$ 1,007,187.50
44	$ 104.00	$ 96.00	34.25%	11000	$472,437.50	$ 534,750.00	$ 1,007,187.50
45	$ 105.00	$ 95.00	34.48%	11000	$472,968.75	$ 534,218.75	$ 1,007,187.50
46	$ 106.00	$ 94.00	34.72%	11000	$473,500.00	$ 533,687.50	$ 1,007,187.50

47	$ 107.00	$ 93.00	34.97%	11000	$474,031.25	$ 533,156.25	$ 1,007,187.50
48	$ 108.00	$ 92.00	35.21%	11000	$474,562.50	$ 532,625.00	$ 1,007,187.50
49	$ 109.00	$ 91.00	35.46%	11000	$475,093.75	$ 532,093.75	$ 1,007,187.50
50	$ 110.00	$ 90.00	35.71%	11000	$475,625.00	$ 531,562.50	$ 1,007,187.50
51	$ 111.00	$ 89.00	35.97%	11000	$476,156.25	$ 531,031.25	$ 1,007,187.50
52	$ 112.00	$ 88.00	36.23%	11000	$476,687.50	$ 530,500.00	$ 1,007,187.50
53	$ 113.00	$ 87.00	36.50%	11000	$477,218.75	$ 529,968.75	$ 1,007,187.50
54	$ 114.00	$ 86.00	36.76%	11000	$477,750.00	$ 529,437.50	$ 1,007,187.50
55	$ 115.00	$ 85.00	37.04%	11000	$478,281.25	$ 528,906.25	$ 1,007,187.50
56	$ 116.00	$ 84.00	37.31%	11000	$478,812.50	$ 528,375.00	$ 1,007,187.50
57	$ 117.00	$ 83.00	37.59%	12000	$479,468.75	$ 543,968.75	$ 1,023,437.50
58	$ 118.00	$ 82.00	37.88%	12000	$480,375.00	$ 543,062.50	$ 1,023,437.50
59	$ 119.00	$ 81.00	38.17%	12000	$481,281.25	$ 542,156.25	$ 1,023,437.50
60	$ 120.00	$ 80.00	38.46%	12000	$482,187.50	$ 541,250.00	$ 1,023,437.50
61	$ 121.00	$ 79.00	38.76%	12000	$483,093.75	$ 540,343.75	$ 1,023,437.50
62	$ 122.00	$ 78.00	39.06%	12000	$484,000.00	$ 539,437.50	$ 1,023,437.50
63	$ 123.00	$ 77.00	39.37%	12000	$484,906.25	$ 538,531.25	$ 1,023,437.50
64	$ 124.00	$ 76.00	39.68%	12000	$485,812.50	$ 537,625.00	$ 1,023,437.50
65	$ 125.00	$ 75.00	40.00%	12000	$486,718.75	$ 536,718.75	$ 1,023,437.50
66	$ 126.00	$ 74.00	40.32%	12000	$487,625.00	$ 535,812.50	$ 1,023,437.50
67	$ 127.00	$ 73.00	40.65%	12000	$488,531.25	$ 534,906.25	$ 1,023,437.50
68	$ 128.00	$ 72.00	40.98%	12000	$489,437.50	$ 534,000.00	$ 1,023,437.50
69	$ 129.00	$ 71.00	41.32%	12000	$490,343.75	$ 533,093.75	$ 1,023,437.50
70	$ 130.00	$ 70.00	41.67%	12000	$491,250.00	$ 532,187.50	$ 1,023,437.50
71	$ 131.00	$ 69.00	42.02%	12000	$492,156.25	$ 531,281.25	$ 1,023,437.50
72	$ 132.00	$ 68.00	42.37%	12000	$493,062.50	$ 530,375.00	$ 1,023,437.50
73	$ 133.00	$ 67.00	42.74%	12000	$493,968.75	$ 529,468.75	$ 1,023,437.50
74	$ 134.00	$ 66.00	43.10%	12000	$494,875.00	$ 528,562.50	$ 1,023,437.50
75	$ 135.00	$ 65.00	43.48%	12000	$495,781.25	$ 527,656.25	$ 1,023,437.50
76	$ 136.00	$ 64.00	43.86%	12000	$496,687.50	$ 526,750.00	$ 1,023,437.50
77	$ 137.00	$ 63.00	44.25%	12000	$497,593.75	$ 525,843.75	$ 1,023,437.50
78	$ 138.00	$ 62.00	44.64%	12000	$498,500.00	$ 524,937.50	$ 1,023,437.50
79	$ 139.00	$ 61.00	45.05%	12000	$499,406.25	$ 524,031.25	$ 1,023,437.50
80	$ 140.00	$ 60.00	45.45%	12000	$500,312.50	$ 523,125.00	$ 1,023,437.50
81	$ 141.00	$ 59.00	45.87%	12000	$501,218.75	$ 522,218.75	$ 1,023,437.50
82	$ 142.00	$ 58.00	46.30%	12000	$502,125.00	$ 521,312.50	$ 1,023,437.50
83	$ 143.00	$ 57.00	46.73%	12000	$503,031.25	$ 520,406.25	$ 1,023,437.50
84	$ 144.00	$ 56.00	47.17%	13000	$504,250.00	$ 512,000.00	$ 1,016,250.00
85	$ 145.00	$ 55.00	47.62%	13000	$505,625.00	$ 510,625.00	$ 1,016,250.00
86	$ 146.00	$ 54.00	48.08%	13000	$507,000.00	$ 509,250.00	$ 1,016,250.00
87	$ 147.00	$ 53.00	48.54%	13000	$508,375.00	$ 507,875.00	$ 1,016,250.00
88	$ 148.00	$ 52.00	49.02%	13000	$509,750.00	$ 506,500.00	$ 1,016,250.00
89	$ 149.00	$ 51.00	49.50%	13000	$511,125.00	$ 505,125.00	$ 1,016,250.00

Appendix 2: Calculations

SkiRetail profit

1. c_u (Marginal Benefit) = Sale Price – Production Cost = $250 - $140 = $110
2. c_0 (Marginal Cost) = Purchase Price – Buy Back Price. [This is calculated for each scenario]
3. Service level, $P(Q^*) = c_u \div (c_u + c_0)$ = [This is calculated for each scenario]
4. The optimal quantity (quantity ordered) is calculated for each scenario based on the service level

The profit calculations of SkiRetail for each scenario are as shown below:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales:
    a. If Quantity Ordered > Demand, then Revenue from sales = Demand × Selling Price
    b. Otherwise, Revenue from sales = Quantity Ordered × Selling Price
3. Revenue from discount sale:
    a. If Quantity Ordered > Demand, then Revenue from discount sale = (Quantity Ordered – Demand) × Buy Back Price
    b. Otherwise, Revenue from discount sale = $0
4. Cost: Quantity Ordered × Purchase Price
5. Profit: (Revenue from sales + Revenue from discount sale) - Cost
6. Expected Profit: Profit × Probability of the scenario
7. Total Expected Profit: Sum of all the expected profits for each scenario

Skiekz profit

The profit calculations of SkiRetail for each scenario are as shown below:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales: Quantity Ordered × Selling Price
3. Variable cost of production: Order Quantity × Variable Cost
4. Cost of buy back:
    a. If Quantity Ordered > Demand, then Cost of buy back = (Quantity Ordered – Demand) × Buy Back Price
    b. Otherwise, Cost of buy back = $0
5. Profit: Revenue from sales – (Variable cost of production + Fixed cost of production + Cost of Buy Back)
6. Expected Profit: Profit × Probability of the scenario
7. Total Expected Profit: Sum of all the expected profits for each scenario

Total Supply chain profit

The total supply chain profit = SkiRetail profit + Skiekz profit for each scenario.

Appendix 3

SkiEkz Sale Price	Marginal Benefit	Marginal Cost	Service Level	Optimal Quantity	SkiRetail Expected Profits	Skiekz Expected Profit	Total Supply Chain Profit
$ 121.00	$ 109.65	$ 61.00	64.25%	17000	$ 1,002,687.50	$108,562.50	$1,111,250.00
$ 122.00	$ 108.80	$ 62.00	63.70%	17000	$ 985,687.50	$125,562.50	$1,111,250.00
$ 123.00	$ 107.95	$ 63.00	63.15%	17000	$ 968,687.50	$142,562.50	$1,111,250.00
$ 124.00	$ 107.10	$ 64.00	62.59%	17000	$ 951,687.50	$159,562.50	$1,111,250.00
$ 125.00	$ 106.25	$ 65.00	62.04%	16000	$ 942,500.00	$177,500.00	$1,120,000.00
$ 126.00	$ 105.40	$ 66.00	61.49%	16000	$ 926,500.00	$193,500.00	$1,120,000.00
$ 127.00	$ 104.55	$ 67.00	60.94%	16000	$ 910,500.00	$209,500.00	$1,120,000.00
$ 128.00	$ 103.70	$ 68.00	60.40%	16000	$ 894,500.00	$225,500.00	$1,120,000.00

$ 129.00	$ 102.85	$ 69.00	59.85%	16000	$ 878,500.00	$241,500.00	$1,120,000.00
$ 130.00	$ 102.00	$ 70.00	59.30%	15000	$ 870,546.88	$252,265.63	$1,122,812.50
$ 131.00	$ 101.15	$ 71.00	58.76%	15000	$ 855,546.88	$267,265.63	$1,122,812.50
$ 132.00	$ 100.30	$ 72.00	58.21%	15000	$ 840,546.88	$282,265.63	$1,122,812.50
$ 133.00	$ 99.45	$ 73.00	57.67%	15000	$ 825,546.88	$297,265.63	$1,122,812.50
$ 134.00	$ 98.60	$ 74.00	57.13%	15000	$ 810,546.88	$312,265.63	$1,122,812.50
$ 135.00	$ 97.75	$ 75.00	56.58%	15000	$ 795,546.88	$327,265.63	$1,122,812.50
$ 136.00	$ 96.90	$ 76.00	56.04%	15000	$ 780,546.88	$342,265.63	$1,122,812.50
$ 137.00	$ 96.05	$ 77.00	55.50%	15000	$ 765,546.88	$357,265.63	$1,122,812.50
$ 138.00	$ 95.20	$ 78.00	54.97%	15000	$ 750,546.88	$372,265.63	$1,122,812.50
$ 139.00	$ 94.35	$ 79.00	54.43%	15000	$ 735,546.88	$387,265.63	$1,122,812.50
$ 140.00	$ 93.50	$ 80.00	53.89%	15000	$ 720,546.88	$402,265.63	$1,122,812.50
$ 141.00	$ 92.65	$ 81.00	53.35%	15000	$ 705,546.88	$417,265.63	$1,122,812.50
$ 142.00	$ 91.80	$ 82.00	52.82%	14000	$ 701,062.50	$412,687.50	$1,113,750.00
$ 143.00	$ 90.95	$ 83.00	52.29%	14000	$ 687,062.50	$426,687.50	$1,113,750.00
$ 144.00	$ 90.10	$ 84.00	51.75%	14000	$ 673,062.50	$440,687.50	$1,113,750.00
$ 145.00	$ 89.25	$ 85.00	51.22%	14000	$ 659,062.50	$454,687.50	$1,113,750.00
$ 146.00	$ 88.40	$ 86.00	50.69%	14000	$ 645,062.50	$468,687.50	$1,113,750.00
$ 147.00	$ 87.55	$ 87.00	50.16%	14000	$ 631,062.50	$482,687.50	$1,113,750.00
$ 148.00	$ 86.70	$ 88.00	49.63%	13000	$ 628,812.50	$469,937.50	$1,098,750.00
$ 149.00	$ 85.85	$ 89.00	49.10%	13000	$ 615,812.50	$482,937.50	$1,098,750.00
$ 150.00	$ 85.00	$ 90.00	48.57%	13000	$ 602,812.50	$495,937.50	$1,098,750.00
$ 151.00	$ 84.15	$ 91.00	48.04%	13000	$ 589,812.50	$508,937.50	$1,098,750.00
$ 152.00	$ 83.30	$ 92.00	47.52%	13000	$ 576,812.50	$521,937.50	$1,098,750.00
$ 153.00	$ 82.45	$ 93.00	46.99%	13000	$ 563,812.50	$534,937.50	$1,098,750.00
$ 154.00	$ 81.60	$ 94.00	46.47%	12000	$ 563,796.88	$514,015.63	$1,077,812.50
$ 155.00	$ 80.75	$ 95.00	45.95%	12000	$ 551,796.88	$526,015.63	$1,077,812.50
$ 156.00	$ 79.90	$ 96.00	45.42%	12000	$ 539,796.88	$538,015.63	$1,077,812.50
$ 157.00	$ 79.05	$ 97.00	44.90%	12000	$ 527,796.88	$550,015.63	$1,077,812.50
$ 158.00	$ 78.20	$ 98.00	44.38%	12000	$ 515,796.88	$562,015.63	$1,077,812.50
$ 159.00	$ 77.35	$ 99.00	43.86%	12000	$ 503,796.88	$574,015.63	$1,077,812.50
$ 160.00	$ 76.50	$100.00	43.34%	12000	$ 491,796.88	$586,015.63	$1,077,812.50
$ 161.00	$ 75.65	$101.00	42.82%	12000	$ 479,796.88	$598,015.63	$1,077,812.50
$ 162.00	$ 74.80	$102.00	42.31%	12000	$ 467,796.88	$610,015.63	$1,077,812.50
$ 163.00	$ 73.95	$103.00	41.79%	12000	$ 455,796.88	$622,015.63	$1,077,812.50
$ 164.00	$ 73.10	$104.00	41.28%	12000	$ 443,796.88	$634,015.63	$1,077,812.50
$ 165.00	$ 72.25	$105.00	40.76%	12000	$ 431,796.88	$646,015.63	$1,077,812.50
$ 166.00	$ 71.40	$106.00	40.25%	12000	$ 419,796.88	$658,015.63	$1,077,812.50
$ 167.00	$ 70.55	$107.00	39.74%	12000	$ 407,796.88	$670,015.63	$1,077,812.50
$ 168.00	$ 69.70	$108.00	39.22%	12000	$ 395,796.88	$682,015.63	$1,077,812.50
$ 169.00	$ 68.85	$109.00	38.71%	12000	$ 383,796.88	$694,015.63	$1,077,812.50
$ 170.00	$ 68.00	$110.00	38.20%	12000	$ 371,796.88	$706,015.63	$1,077,812.50
$ 171.00	$ 67.15	$111.00	37.69%	12000	$ 359,796.88	$718,015.63	$1,077,812.50
$ 172.00	$ 66.30	$112.00	37.18%	11000	$ 364,484.38	$674,578.13	$1,039,062.50
$ 173.00	$ 65.45	$113.00	36.68%	11000	$ 353,484.38	$685,578.13	$1,039,062.50
$ 174.00	$ 64.60	$114.00	36.17%	11000	$ 342,484.38	$696,578.13	$1,039,062.50
$ 175.00	$ 63.75	$115.00	35.66%	11000	$ 331,484.38	$707,578.13	$1,039,062.50
$ 176.00	$ 62.90	$116.00	35.16%	11000	$ 320,484.38	$718,578.13	$1,039,062.50
$ 177.00	$ 62.05	$117.00	34.66%	11000	$ 309,484.38	$729,578.13	$1,039,062.50
$ 178.00	$ 61.20	$118.00	34.15%	11000	$ 298,484.38	$740,578.13	$1,039,062.50
$ 179.00	$ 60.35	$119.00	33.65%	11000	$ 287,484.38	$751,578.13	$1,039,062.50
$ 180.00	$ 59.50	$120.00	33.15%	11000	$ 276,484.38	$762,578.13	$1,039,062.50
$ 181.00	$ 58.65	$121.00	32.65%	11000	$ 265,484.38	$773,578.13	$1,039,062.50
$ 182.00	$ 57.80	$122.00	32.15%	11000	$ 254,484.38	$784,578.13	$1,039,062.50

$ 183.00	$ 56.95	$123.00	31.65%	11000	$ 243,484.38	$795,578.13	$1,039,062.50
$ 184.00	$ 56.10	$124.00	31.15%	11000	$ 232,484.38	$806,578.13	$1,039,062.50
$ 185.00	$ 55.25	$125.00	30.65%	11000	$ 221,484.38	$817,578.13	$1,039,062.50
$ 186.00	$ 54.40	$126.00	30.16%	11000	$ 210,484.38	$828,578.13	$1,039,062.50
$ 187.00	$ 53.55	$127.00	29.66%	11000	$ 199,484.38	$839,578.13	$1,039,062.50
$ 188.00	$ 52.70	$128.00	29.16%	11000	$ 188,484.38	$850,578.13	$1,039,062.50
$ 189.00	$ 51.85	$129.00	28.67%	11000	$ 177,484.38	$861,578.13	$1,039,062.50
$ 190.00	$ 51.00	$130.00	28.18%	11000	$ 166,484.38	$872,578.13	$1,039,062.50
$ 191.00	$ 50.15	$131.00	27.68%	10000	$ 176,875.00	$805,625.00	$982,500.00
$ 192.00	$ 49.30	$132.00	27.19%	10000	$ 166,875.00	$815,625.00	$982,500.00
$ 193.00	$ 48.45	$133.00	26.70%	10000	$ 156,875.00	$825,625.00	$982,500.00
$ 194.00	$ 47.60	$134.00	26.21%	10000	$ 146,875.00	$835,625.00	$982,500.00
$ 195.00	$ 46.75	$135.00	25.72%	10000	$ 136,875.00	$845,625.00	$982,500.00
$ 196.00	$ 45.90	$136.00	25.23%	10000	$ 126,875.00	$855,625.00	$982,500.00
$ 197.00	$ 45.05	$137.00	24.75%	9000	$ 139,500.00	$780,500.00	$920,000.00
$ 198.00	$ 44.20	$138.00	24.26%	9000	$ 130,500.00	$789,500.00	$920,000.00
$ 199.00	$ 43.35	$139.00	23.77%	9000	$ 121,500.00	$798,500.00	$920,000.00

Appendix 4: Calculations

1. c_u (Marginal Benefit) = (SkiRetail Sale Price – Skiekz Sale Price) × (Percentage of revenue retained by SkiRetail) [This is calculated for each scenario]
2. c_0 (Marginal Cost) = Skiekz Sale Price – Salvage Value [This is calculated for each scenario]
3. Service level, $P(Q^*) = c_u \div (c_u + c_0)$ = [This is calculated for each scenario]
4. The optimal quantity (quantity ordered) is calculated for each scenario based on the service level

SkiRetail profit

The profit calculations of SkiRetail for each scenario are as shown below:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales:
    a. If Quantity Ordered > Demand, then Revenue from sales = Demand × Selling Price
    b. Otherwise, Revenue from sales = Quantity Ordered × Selling Price
3. Revenue from discount sale:
    a. If Quantity Ordered > Demand, then Revenue from discount sale = (Quantity Ordered – Demand) × Salvage value
    b. Otherwise, Revenue from discount sale = $0
4. Purchase Cost: Quantity Ordered × Skiekz Sale Price
5. Revenue Share cost: 15% × Revenue from sales
6. Profit: Revenue from sales + Revenue from discount sale - (Purchase cost + Revenue share cost)
7. Expected Profit: Profit × Probability of the scenario
8. Total Expected Profit: Sum of all the expected profits for each scenario

Skiekz profit

The profit calculations of SkiRetail for each scenario are as shown below:

1. The demand and the probabilities are taken from the frequency table
2. Revenue from sales: Quantity Ordered × Skiekz Selling Price
3. Revenue from revenue share: 15% × Revenue from SkiRetail sales
4. Variable cost of production: Order Quantity × Variable Cost
5. Profit: (Revenue from sales + Revenue from revenue share) - (Variable cost of production + Fixed cost of production)
6. Expected Profit: Profit × Probability of the scenario
7. Total Expected Profit: Sum of all the expected profits for each scenario

Total Supply chain profit

The total supply chain profit = SkiRetail profit + Skiekz profit for each scenario.