

Supplementary material

A Behavioral Investigation of Supply Chain Contracts for a Newsvendor Problem in a Developing Economy

SM 1. Sample of instructions (salvage contract condition)

INSTRUCTIONS

The purpose of this exercise is to explore **contractual arrangements** for storage technologies in the agricultural supply chain in Uganda. We will think of an arrangement as a set of agreements that decide what prices firms in the supply chain face. Contractual arrangements can be used to incentivize production decisions beneficial for the supply chain.

We will explore a **salvage arrangement** between a metal silo manufacturer and the World Food Program (WFP). Under a salvage arrangement, WFP buys any unsold silos the manufacturer has at the end of the harvest season. WFP pays a salvage or recover price for each unsold silo. However, it is typical in salvage arrangements that the recover price is less than the manufacturing cost. In other words, **the manufacturer is able to recover a fraction of the money she spent when she manufactured the silos she was not able to sell throughout the harvest season.**

The principle of a salvage arrangement

Imagine the Uganda National Football Team will play the 2018 FIFA World Cup. You want to do some business taking advantage of the occasion and purchase 100 jerseys of the Uganda National Football Team to sell them during the World Cup days.

Imagine you paid Sh 100,000 for each jersey, and sell each at Sh 150,000.

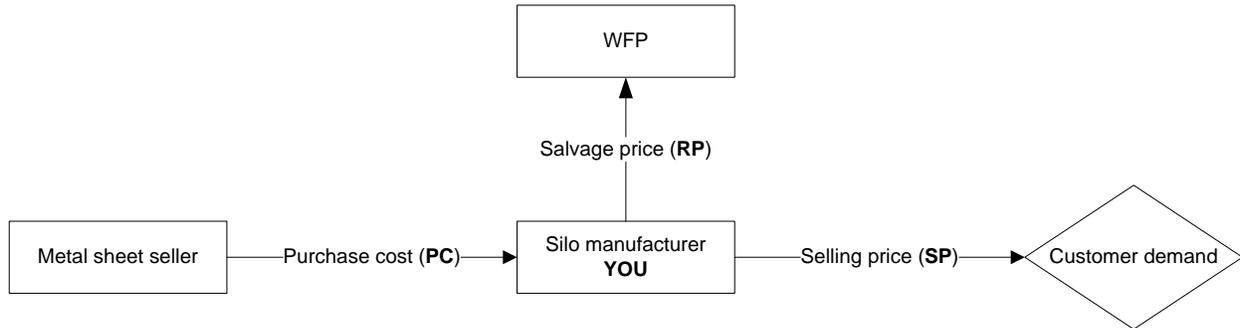
By the time the World Cup finished, you were able to sell 90 jerseys. However, because the World Cup finished, people are not willing to buy the remaining 10 jerseys at Sh 150,000 anymore since they feel the jerseys have lost their original value.

With that in mind, imagine people come to you and tell you they would buy the remaining jerseys if you offer them at Sh 80,000 each.

After a couple of days, you sell the remaining 10 jerseys at Sh 80,000 each. Instead of having lost Sh 100,000 for each remaining jersey, you only lost Sh 20,000 since you were able to recover Sh 80,000 by selling them at a lower price.

Under a salvage arrangement, you recover a fraction of the value of finished products.

DESCRIPTION OF SETTING



You are a manufacturer of metal silos. In order to manufacture silos, you purchase metal sheets from a metal sheet seller. You then manufacture the silos and sell them throughout the harvest season. If at the end of the harvest season you still have silos, WFP buys them at a price lower than their manufacturing cost.

Assumptions

- The metal sheet seller has an unlimited supply of sheets. This allows you to purchase as many sheets as you want.
- Manufacturing one silo requires one sheet.

For example, if you want to manufacture 50 silos, you have to purchase 50 sheets.

- The labor cost is negligible compared with the purchase cost. Then, the manufacturing cost of a silo is equal to the purchase cost of the sheet.

For example, if the purchasing cost of a sheet is Sh 160,000, the manufacturing cost of the silo is Sh 160,000.

Parameters

You purchase sheets from the metal sheet seller at a given purchase cost each sheet.

- We represent the purchase cost of a sheet as Sh **PC**.

You sell silos to customers at a given selling price each silo.

- We represent the selling price of a silo as Sh **SP**.

You must purchase sheets and manufacture the silos before the harvest season even begins. This allows you to have the silos ready by the time the harvest season begins. This means you purchase sheets and manufacture the silos before you know for certain how many silos customers will want to buy throughout the harvest season.

- We call the amount of sheets you decide to purchase the *purchase quantity*, and represent it as **Q**.

- We call the amount of silos customers will want to buy throughout the harvest season the *demand*, and represent it as **D**.

At the end of the harvest season, after customers have finished buying silos, you want to evaluate your performance. This evaluation depends on the following demand scenarios:

Demand scenario 1: you purchased enough sheets to satisfy your demand throughout the harvest season.

Under this scenario, your purchase quantity **Q** was greater than the demand **D**:

Your manufacturing cost is **PC x Q**
Your sales revenue is **SP x D**

This demand scenario means you have unsold silos at the end of the harvest season. **However, there is a salvage arrangement between you and WFP.** For each unsold silo, WFP pays you a fraction of its manufacturing cost.

- We represent the recover price of a silo as Sh **RP**.

Your recover revenue is **RP x (Q – D)**

Profit

Your profit is:

$$\begin{array}{rcccl} \text{Sales revenue} & & & & \\ \text{SP x D} & + & \text{Recover revenue} & - & \text{Manufacturing cost} \\ & & \text{RP x (Q – D)} & & \text{PC x Q} \end{array}$$

Demand scenario 2: you did not purchase enough sheets to satisfy your demand throughout the harvest season

Under this scenario, your purchase quantity **Q** was less than the demand **D**

Your manufacturing cost is **PC x Q**
Your sales revenue is **SP x Q**

This demand scenario means there are customers who wanted to buy silos but could not buy them. This means you could have sold more silos had you decided to purchase more sheets. **You lose sales revenue for each silo customers wanted to buy but could not buy.**

- We represent lost sales revenue as **SP x (D – Q)**.

Profit

Your profit is:

$$\begin{array}{rcccl} \text{Sales revenue} & & & & \text{Manufacturing cost} \\ \text{SP x Q} & - & & & \text{PC x Q} \end{array}$$

Demand

Based on forecast information from WFP's pilot programs on storage technologies in the agricultural supply chain in Uganda, you know the following about the demand.

- The minimum or lowest value of silos customers will want to buy throughout the harvest season is 450 silos (minimum demand).
- The maximum or highest value of silos customers will want to buy throughout the harvest season is 550 silos (maximum demand).
- Any value within the minimum and maximum demand can happen with equal chance.

To give you an idea about the demand, a sample of 30 demand observations could look as follows:

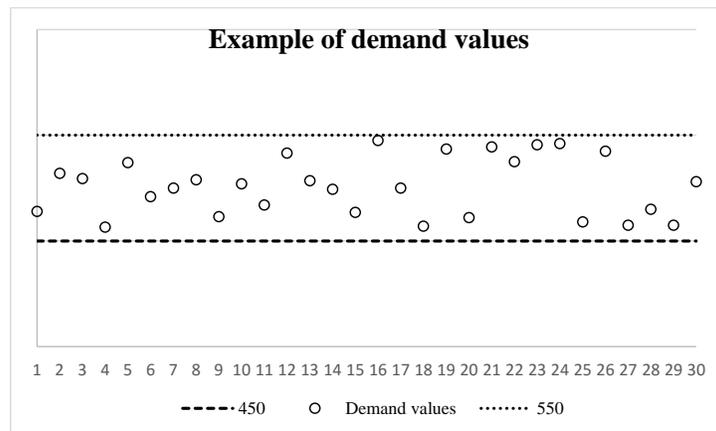


Figure 1. Demand sample.

EXAMPLES

Example 1

Selling price =	510,000 Sh/silo
Purchase cost =	150,000 Sh/sheet
Recover price =	100,000 Sh/silo

Assume:

Purchase quantity (Q) =	460 sheets
Demand (D) =	540 silos

Then:

Silos sold =	460 silos
Unsold silos =	Since $D > Q$, unsold silos = 0 silos
Non-satisfied silo demand =	Since $D > Q$, non-satisfied silo demand = $540 - 460 = 80$ silos
Manufacturing cost =	$150,000 \times 460 = \text{Sh } 69,000,000$
Sales revenue =	$510,000 \times 460 = \text{Sh } 234,600,000$

Recover revenue =	Since $D > Q$, recover revenue = Sh 0
Lost sales revenue =	Since $D > Q$, lost sales revenue = $510,000 \times 80 = \text{Sh } 40,800,000$

Profit = $234,600,000 - 69,000,000 = \text{Sh } 165,600,000$

Example 2

Selling price = 510,000 Sh/silo
Purchase cost = 150,000 Sh/sheet
Recover price = 100,000 Sh/silo

Assume:

Purchase quantity = 540 sheets
Demand = 460 silos

Then:

Silos sold = 460 silos
Unsold silos = Since $Q > D$, unsold silos = $540 - 460 = 80$ silos
Non-satisfied silo demand = Since $Q > D$, non-satisfied silo demand = 0 silos

Manufacturing cost = $150,000 \times 540 = \text{Sh } 81,000,000$
Sales revenue = $510,000 \times 460 = \text{Sh } 234,600,000$

Recover revenue = Since $Q > D$, recover revenue = $100,000 \times 80 = \text{Sh } 8,000,000$
Lost sales revenue = Since $Q > D$, lost sales revenue = Sh 0

Profit = $234,600,000 + 8,000,000 - 81,000,000 = \text{Sh } 161,600,000$

YOUR TASK & GOAL

We are going to give you 42 decision problems: 28 in phase 1 and 14 in phase 2. A sample of a decision problem looks as follows:

DECISION PROBLEM, SALVAGE

Selling price = X Sh/silo

Purchase cost = Y Sh/sheet

Recover price = Z Sh/silo

Your purchase quantity = _____ sheets

Each problem will contain a different combination of selling price, purchase cost and recover price. For each of these problems, your task is to decide a purchase quantity you think will maximize your profit given the demand's forecast information.

Your goal is to decide purchase quantities you think will maximize your average profit over the 42 decision problems.

OBSERVATIONS

- Write down your purchase quantities using a pen. Do not use pencil.
- You are not allowed to change a purchase quantity once you have written it down. Purchase quantities with any kind of crossings out are invalid.
- You are not allowed to share information with other participants by any means (neither verbal nor nonverbal).

Please follow these observations. Otherwise, your participation may be terminated by the investigators and you will be given only a show-up fee.

SM 2. Sample of manipulation check (salvage contract condition)

EXERCISES, SALVAGE

Exercise 1

Selling price = 510,000 Sh/silo
Purchase cost = 170,000 Sh/sheet
Recover price = 90,000 Sh/silo

Assume:

Purchase quantity (Q) = 520 sheets
Demand (D) = 530 silos

Compute:

Silos sold = _____ silos

Unsold silos = _____ silos

Non-satisfied silo demand = _____ silos

Manufacturing cost = Sh _____

Sales revenue = Sh _____

Recover revenue = Sh _____

Lost sales revenue = Sh _____

Profit = Sh _____

Exercise 2

Selling price = 510,000 Sh/silo
Purchase cost = 170,000 Sh/sheet

Recover price = 90,000 Sh/silo

Assume:

Purchase quantity (Q) = 520 sheets

Demand (D) = 470 silos

Compute:

Silos sold = _____ silos

Unsold silos = _____ silos

Non-satisfied silo demand = _____ silos

Manufacturing cost = Sh _____

Sales revenue = Sh _____

Recover revenue = Sh _____

Lost sales revenue = Sh _____

Profit = Sh _____

SM 3. Sample of index card (salvage contract condition)

DECISION PROBLEM, SALVAGE	
Selling price = _____	Sh/silo
Purchase cost = _____	Sh/sheet
Recover price = _____	Sh/silo
Your purchase quantity = <input type="text"/>	sheets