



GLOBAL JOURNAL OF MANAGEMENT AND BUSINESS RESEARCH: A
ADMINISTRATION AND MANAGEMENT
Volume 14 Issue 3 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4588 & Print ISSN: 0975-5853

Economic Discounting and Stocking of Perishables: A Simulation based Approach for Wholesalers

By Lamay Bin Sabir, Jamal A. Farooquie & Asad Ullah

Aligarh Muslim University, India

Abstract- Customers are more particular about shelf life, taste and nutritious value of products when it comes to perishables, as compared to non-perishables, especially food items. Decisions related to stock size, price discounts, and aftershef- life uses of such goods are relatively difficult to take. The majority of wholesaler of perishables generally manages their inventories and profit on know-how basis rather than using any objective criteria. This paper is based on a study conducted lately by the authors on inventory management and performance of supply chains of perishables. Monte Carlo simulation approach is used in this paper to find out economic stock size, amount and period of price discounts, and expected profit for wholesalers supplying eggs to a local market. The framework of this study has been adapted from two previously published studies on a related issue.

Keywords: inventory; perishable; profit; simulation.

GJMBR-A Classification: JEL Code: C15, L42



Strictly as per the compliance and regulations of:



© 2014. Lamay Bin Sabir, Jamal A. Farooquie & Asad Ullah. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License (<http://creativecommons.org/licenses/by-nc/3.0/>), permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Economic Discounting and Stocking of Perishables: A Simulation based Approach for Wholesalers

Lamay Bin Sabir ^α, Jamal A. Farooque ^σ & Asad Ullah ^ρ

Abstract- Customers are more particular about shelf life, taste and nutritious value of products when it comes to perishables, as compared to non-perishables, especially food items. Decisions related to stock size, price discounts, and after-shelf-life uses of such goods are relatively difficult to take. The majority of wholesaler of perishables generally manages their inventories and profit on know-how basis rather than using any objective criteria. This paper is based on a study conducted lately by the authors on inventory management and performance of supply chains of perishables. Monte Carlo simulation approach is used in this paper to find out economic stock size, amount and period of price discounts, and expected profit for wholesalers supplying eggs to a local market. The framework of this study has been adapted from two previously published studies on a related issue.

Keywords: *inventory; perishable; profit; simulation.*

I. INTRODUCTION

To classify every entity as perishable or not, we need to establish the threshold value for the shelf life. Examination of the data has revealed that all products which require a conditioned environment have a shelf life that is equal to or less than 30 days (Donselaar et. al., 2003). Consequently, in this paper we have defined perishable life of the product as less than or equal to 30 days. K. van Donselaar (2003) applied this definition to the entire assortment (including here weight products and direct deliveries) in his paper and estimated that roughly 15% of the assortments are perishables versus 85% non-perishables. Commodities that have predetermined useful life are said to be perishable commodities (Gupta et. al., 2003). Common examples include decomposing organic products such as vegetables, fruits, daily bread, milk and meat etc. Perishable commodities may also have fixed life time, after which they are not useful for the use, such as medicines, packaged juices (for which lifetime is different when opened) etc.

Our paper is based on already published two papers in which discounts are offered and they have considered 30 day perishable product with fixed lifetime

(Sezen, B., 2004, Ramanathan, R., 2006). In our paper we have considered only “egg” as a perishable product since it is a commodity which is used as a regular item in the household and have a seasonal lifetime of 2-5 weeks which is close enough to analyze the discount approach of Sezen (2004) and Ramanathan (2006).

II. LITERATURE REVIEW

Numerous models have been developed in literature so that inventory management of perishable products can be easily understood and it can be useful in accepting complex situations of perishability. Some complex models including returns policies (Vlachos, D. and Dekker, R. 2003, Hahn, K.H, et. al, 2004), ordering policies for cyclic commodities (Gupta et. al., 2003), demand with time variance, production and deterioration rates (Goyal, S.K. and Giri, B.C., 2003) have also been developed in the literature.

Problem related to discounting and stocking decisions for short shelf life perishable commodities has not attained the due magnitude in literature (Ramanathan, R., 2006). Decisions regarding discounts have been considered in some somewhat old articles, while there seems to be an improved interest in taking into account discounting policies in some recent articles (Arcelus, F.J., 2003, Sezen, B., 2004, Ramanathan, R., 2006).

Abad (2001), with an objective of profit per period, allows for elastic pricing, assuming that the perishables are price sensitive. His procedure is relatively simple and can be implemented on a spread sheet. Similarly, in a different inventory model of Abad (2003), the decision variable is the selling price of the product. Teng et al. (2007) have widened his model with additional costs of backlogging and lost goodwill. Tsao and Sheen (2008), with the same intention of maximizing net profit; show that dynamic decision-making is superior to fixed decision-making in terms of retail price and promotional effort. In practice, it is common to put forward deteriorated items at a discounted price. In many supermarkets, items that are near their expiration date are marked down by a fixed percentage to manipulate the consumer's buying behavior. Such price discounts are addressed in numerous papers (Sezen, B., 2004, Ramanathan, R., 2006, Li, Y. et. al., 2008,

Author α σ ρ: Department of Business Administration, Aligarh Muslim University (AMU), India. e-mail: lbsabir.rs@amu.ac.in, jamalfarooque@yahoo.co.in, asad_hazari@yahoo.com

Warburton, R.D.H., 2009, Cai, X. 2009, Chew, E.P., et. al. 2009, Akcay, Y. 2010, Krishnan, H. and Winter, R.A. 2010, Chang, H.J. et. al. 2011, Li, Y. et. al. 2011). Monitoring and organizing of perishable products can be facilitated by the applying radio frequency identification (RFID) and a policy of dynamic pricing (Berk, E. et. al. 2009, Bisi, A. and Dada, M. 2007), such as discounts when the item reaches a predetermined age. Ferguson and Koenigsberg (2009) discuss the probable cannibalization effect of having both high-priced fresh products and low-priced older products in same shelf. Ramanathan (2006) and Sezen (2004) assume two discount rates for the first and second discount period in their models.

Arcelus et al. (2003) provide a model with payment reduction schemes other than temporary price discounts. They presume that the vendor's trade advertising is a mix of credit and/or price discount. For the retailer, the model determines the size of the special order to be placed at the vendor, the price and/or credit-terms incentives to be passed onto customers and the quantity to be sold under these one-time-only situations. In the model by Tsao and Sheen (2007) the price discount is a function of both quantity and time of order placement whereas Lin et al. (2009) presume a selling price that decreases linearly with time and customer demand linearly increases with the same.

Sezen (2004) provides an interesting procedure to empirically identify optimal discounting policies for perishable commodities and is further elaborated by Ramanathan (2006). Sezen (2004) has used expected profit approach to identify the timing and quantum of discount for perishable commodities while Ramanathan (2006) used probability distributions to justify the probability of selling the perishable product along with no. of units to be stocked. Ramanathan (2006) extends the expected profit approach from Sezen (2004) by including decisions on the quantities of the perishable products to be stocked by the retailer.

This paper attempts to extend the expected profit approach presented in Sezen (2004) & Ramanathan (2006) by including decisions on the quantities of the perishable products to be stocked by the retailer and adding the cost incurred variable holding cost, cost of revenue/waste generated after the end of shelf life. Their findings are duplicated with data taken from wholesalers who sells perishable commodity like eggs.

Section 3 deals with the objectives and methodology followed by us in this paper. Section 4 will propose the expected profit equation with notations followed by Sezen (2004) and Ramakrishnan (2006). Section 5 deals with data collected from the wholesale market and use of Monte-Carlo simulation technique to analyze the best possible discount period, with specifically eggs taken as perishable commodity with summarized results. Section 6, is conclusions and future research directions.

III. OBJECTIVES AND METHODOLOGY

As discussed earlier, this study is the continuation of two previous studies (Sezen, B., 2004, Ramanathan, R., 2006) in which they have considered a perishable commodity of shelf life 30 days. In our study we are extending this by taking revenue/waste cost after the shelf life of the product has expired. We are also considering variable holding cost as this was not the case for the studies done earlier. Keeping this in light, our objectives are:

- To optimize the number of items to be stocked by the wholesaler seasonally and the quantum of discount to be offered.
- To identify the best possible time to offer the discount.
- To minimize the unsold inventory and hence maximize the profit.

As we know that the demand patterns for such type of commodities cannot be exactly known. Stochastic demand patterns are considered as closest way to analyze the situation in terms of perishable products. Such demand patterns are considered very rarely in the literature (Gurler, U. and Yuksel Ozkaya, B. 2003, Berk, E. et. al. 2009, Li, Y. et. al. 2011). After discussing with the wholesalers, we understand that approximately 65-70% of their demands are constant throughout year due to fixed retailer market. Therefore we have taken 70% demand pattern for normal period of sales to make our calculations easier. Demand for first discounted period as well as for units unsold even after discount are randomly generated using the RAND command in excel. Since we have considered probability distribution as arbitrary, again RAND command in excel is used to generate the probabilities for the respective periods of normal demand, discounted demand, and unsold demand.

The excel sheet for monte-carlo simulation is run for 1000 trials for profit, making the demand and probability pattern selection totally random. In using a Monte-Carlo modeling approach, a higher number of realizations usually leads to a more reliable and convergent result. Results are said to be converged if the estimate of a particular percentile value does not change significantly if additional Monte-Carlo simulations are performed. However, it is not generally possible to determine beforehand how many realizations are needed to achieve a specified degree of convergence since the value can be highly dependent on parameter distributions. Once profit and the probabilities of all the combinations of D0, D1 are computed, the expected profit can be calculated (table 1).

If the demand patterns during normal and discount period are assumed to be independent, then the probability of obtaining the above decisions for

perishable commodities over profit is the product of $P(D_0)$, $P(D_1)$ and $P(NS)$ (Ramanathan, R., 2006). Once profit and the probabilities of all the combinations of D_0 , D_1 and NS are computed, the expected profit can be calculated. This expected profit provides a guide for the choice of the number of units to be stocked (n), appropriate times (t) of beginning the discount and the quanta of discounts (d).

P	-	selling price per unit
C	-	purchasing cost per unit
h	-	holding cost per day per unit
d	-	discount rate (in percentage of the original selling price)
t	-	starting time of the discount period in days
ShL	-	shelf life ($ShL \geq t$)
n	-	number of items stocked
D_0	-	number of items demanded during normal period (when there is no discount)
$P(D_0)$	-	probability of the number of items demanded during normal period (assumed to vary depending upon t , d)
D_1	-	number of items demanded during the discount period
$P(D_1)$	-	probability distribution of the number of items demanded during the discount period (assumed to vary depending upon t_1 , d_1)
NS	-	number of items not sold at the end of shelf life.
$P(NS)$	-	probability of the number of items not sold even after offering discount.
$R(NS)$	-	if the unsold, perished item is taken back by the manufacturer/ or sale.
PFT0	-	profit per unit when the product is sold in the normal (no-discount) period
PFT1	-	profit per unit when the product is sold during the discount period
PFTns	-	loss per unit when the product is not sold in any period but can have resale resulting in some revenue.

Items are placed on shelf for sale at time 0 and sold at price P without any discount during the normal period (time 0 to time t). If there are items unsold at the end of a pre-specified period t and until the shelf-life of the product, discount policy is applied to encourage consumers buy before the product expires. If the product is sold between the time period t to SHL , a discount d is applied so that the selling price is $p \times (1 - d)$. In our paper, we have assumed the following:

- All arriving items are new and their lifetime starts when they are placed on the shelf;
- The unsold products at the end of shelf-life are disposed with some extra cost or revenue.
- Purchase cost c is constant.
- There is a fixed demand rate in normal period for both summer and winter seasons.

IV. PROPOSED EXPECTED PROFIT APPROACH FOR STOCKING AND DISCOUNTING DECISIONS

We consider one discount period in this model. In view of the fact that it is not possible for the wholesaler to give extra discount due to short shelf life of the product. To provide continuity, we have attempted to use, as far as possible, the same notations used by Sezen ((Sezen, B., 2004)) and Ramanathan ((Ramanathan, R., 2006)). The following are the notations used.

a) *Mathematical Relationships*

During the total shelf life of the product, we assume three time phases in which three different prices can be applied. The first period, the normal (no-discount) period, is the time between the placement of the egg crates on the shelf and the start of the first discount at time t . The selling price in the normal period is p . The second period, the discount period, is the time in which the discount price is applied until the end shelf life of the eggs. The selling price in the first discount period is equal to $p(1-d)$, where d is the discount rate for this period. Finally, the last period, where the product is not sold even after offering discount, occurs after the end of shelf life.

In a local market such as Aligarh, cost of waste is negligible due to the fact that expired; unsold eggs are thrown away in bins. Hence we have taken the cost

of waste as negligible as it does not affect the overall cost of the wholesaler. The profit for normal period can be calculated as:

$$PFT_0 = \{(selling\ price) - (purchasing\ cost + average\ holding\ cost)\} \times no.\ of\ units\ sold\ in\ normal\ period$$

$$= \{p - (c + t \times h / 2)\} \times D_0$$

Here, since we do not know the precise moment in time of selling the product, the average holding cost is roughly found by taking the half of t and multiplying the result by the unit holding cost h. For the first discount period, the selling price is discounted by the rate d. In addition, if the product is sold in the

discount period, the holding cost will rise because the product is carried beyond the normal period. Therefore, profit per unit for a product sold in the first discount period is calculated as follows:

$$PFT_1 = \{p(1 - d) - (c + t \times h + ((SHL - t) \times h) \div 2)\} \times D1$$

Since the product is held (not sold) until the first discount period, inventory holding cost is the sum of inventory costs for the entire normal period (t x h) and the half of the unsold period.

amount for their disposal for next lot. These eggs are sold to the manufacturers of poultry feed at a lower cost. Therefore, we have tried to inculcate such cost also. This additional cost can be termed as revenue for the wholesaler's. It can be denoted as:

$$R = NS \times c_1 \quad \text{where } c_1 \leq c$$

In case where the manufacturer is able to return the unsold item back to other manufacturer then it can be accounted for revenue. It simply reduces the cost of the wholesaler. Some local bakery manufacturers often buy from them in order to serve their needs and reduce the overall costs of buying. Sometimes, big wholesalers put pressure on "mandis" i.e. local poultry markets, to take the lot of waste eggs back and charge a small

When the product is not sold in any of these periods, in that case, instead of a profit value we find a quantity of loss and may generate some revenue. The equation will be:

$$PFTns = Revenue - (cost\ of\ the\ lot\ unsold + holding\ cost)$$

$$= \{c1 - (c + (SHL) \times h)\} \times NS$$

Here, ShL x h gives us the total holding cost for the product because it is kept on the shelf until the end of its expiry date. We assume that the cost of removing and disposing the unsold products is negligible.

is the probability of not selling the product. Since these probabilities (P₀, P₁ and P_{ns}) are collectively exhaustive, that is, at least one must occur in any condition, their total should be 1. With these probabilities and the profit per unit values, the expected profit can be found by using the common expected value approach (Ramanathan, R., 2006):

For any given discount rate and time combination (d, t), assume that P₀, P₁ are the probabilities for selling a product in the normal period, discount period respectively. Further, assume that P_{ns}

$$(Expected\ profit)_i = P_0(PFT_0) + P_1(PFT_1) + Pns(PFTns)$$

Therefore for 1000 trials expected profit is the average of all the scenarios randomly generated, which can be represented as:

$$Average\ Expected\ profit = \frac{\sum_{i=1}^{1000} (Expected\ profit)_i}{1000}$$

V. DATA ANALYSIS

In India, egg is a commodity used in large quantity which has a short shelf life. As Sezen ((Sezen, B., 2004)) & Ramanathan ((Ramanathan, R., 2006)) tried to support their mathematical relations through assumption of data, we have tried to take the required inputs through wholesaler markets here in Aligarh, India. Egg has a lifetime depending upon the season cycle; hence two type of analysis has been carried out so that

both seasonal discounts can be taken into consideration. For summer season shelf life of eggs are approximately 15 days whereas in winter season 30 days shelf life is considered.

Example here is carried out for winter season, when the shelf life of an egg is approximately 30 days. Data taken under consideration is an average for four wholesalers. They procure eggs from different markets known as 'Mandis', which in turn buy from poultry farms all across Aligarh and nearby areas.



Example: For winter season- shelf life 30 days.

In our case, as we have considered only one discount period, no of days are limited to t – (20, 25 days) with discount values d – (5%, 10%, 15%, 20%). No of items to be stocked are substituted as n – (2000,

3000, 4000, 5000 crates per lot). Holding cost per unit is also calculated as illustrated below. Demand for 1st period, i.e. normal period is assumed to be approximately 70% of overall demand; following calculations are done (Table 1) with data as under.

- p = Rs. 128/ crate of thirty eggs
- c = Rs. 105/ crate of thirty eggs
- h = ((Rent of the shop + Salaries) per day + maintenance per day) / (Total no of eggs per lot) = (84600/30 + 2500/60) / (3000) = 0.045 per crate
- n = No of units to be stocked = 3000 crates
- c₁ = Rs. 60/ crate
- SHL = 30 days
- Discount offered = 5%
- Time of discount = 20th day

Table 1 shows the overall 1000 trails carried in excel for generation of the average expected profit. The expected profit for the 1st scenario (as shown in table 2) can be calculated as:

$$PFT_0 = \{125 - (105 + 20 \times 0.045 / 2)\} \times 1935 = \text{Rs. } 37832.1$$

Similarly PFT1 and PFTns is calculated and expected profit is

$$(Expected\ Profit)_{i=1} = P0x(PFT0) + P1x(PFT1) + Pnsx (PFTns) = 0.04x37832.1 + 0.15x7272.6 + 0.82x(-24077) = -16952.5$$

Therefore for 1000 trails, average of Expected profit is:

$$\begin{aligned} \text{Average Expected Profit} &= \frac{(\text{Exp Profit } 1 + \text{Expected profit } 2 + \dots + \text{Exp Profit } 1000)}{1000} \\ &= \text{Rs. } 12349.55 \end{aligned}$$

The overall summarized table for different discount rates, time of discounts and the no of units to be ordered are shown in table 1.



Table 1: Simulation carried for 1000 trials

S.No.	p	d %	c	c1	t	h	SHL	D0	D1	NS	P0	P1	Pos.	PFT0	PFT1	PFTos.	Exp Profit
1	125	5	105	60	20	0.045	30	1935	538	527	0.04	0.15	0.81	37832.1	7272.6	-24077.2	-16952.5
2	125	5	105	60	20	0.045	30	1994	378	628	0.07	0.14	0.79	38987.3	5106.7	-28692.7	-19396.5
3	125	5	105	60	20	0.045	30	1644	183	1173	0.44	0.17	0.39	32133.0	2479.6	-53578.1	-6313.7
334	125	5	105	60	20	0.045	30	1442	1010	548	0.31	0.55	0.14	28197.4	13655.9	-25029.9	12512.7
335	125	5	105	60	20	0.045	30	1584	833	583	0.30	0.17	0.53	30958.6	11273.1	-26625.8	-2760.4
336	125	5	105	60	20	0.045	30	1671	990	340	0.54	0.17	0.29	32662.9	13383.0	-15518.8	15241.2
777	125	5	105	60	20	0.045	30	1469	801	730	0.64	0.28	0.09	28723.1	10831.6	-33339.5	18373.7
778	125	5	105	60	20	0.045	30	1926	219	856	0.35	0.23	0.42	37649.5	2956.1	-39080.9	-2233.7
.....																	
691	125	5	105	60	20	0.045	30	1663	979	358	0.05	0.43	0.52	32513.7	13240.5	-16348.6	-1179.3
692	125	5	105	60	20	0.045	30	1781	721	498	0.46	0.37	0.17	34822.4	9749.1	-22745.2	15570.0
693	125	5	105	60	20	0.045	30	1662	44	1294	0.35	0.56	0.09	32490.4	599.0	-59094.2	6439.2
744	125	5	105	60	20	0.045	30	1914	537	549	0.46	0.03	0.51	37416.8	7261.8	-25083.9	4368.2
745	125	5	105	60	20	0.045	30	1531	295	1174	0.28	0.38	0.34	29927.2	3991.0	-53627.5	-8593.0
746	125	5	105	60	20	0.045	30	1868	793	339	0.88	0.03	0.09	36521.9	10728.5	-15467.3	30896.5
747	125	5	105	60	20	0.045	30	1539	215	1247	0.75	0.22	0.02	30079.7	2905.3	-56937.7	22088.0
.																	
.																	
.																	
824	125	5	105	60	20	0.045	30	1796	481	722	0.92	0.05	0.04	35115.4	6511.8	-32993.5	31352.0
891	125	5	105	60	20	0.045	30	1993	500	507	0.81	0.15	0.04	38966.5	6757.2	-23167.1	31583.0
892	125	5	105	60	20	0.045	30	1987	117	896	0.20	0.74	0.05	38843.6	1587.8	-40912.1	6867.5
893	125	5	105	60	20	0.045	30	2099	70	831	0.41	0.08	0.51	41040.8	942.3	-37958.3	-2423.9
944	125	5	105	60	20	0.045	30	1453	921	626	0.56	0.25	0.19	28407.9	12461.9	-28570.3	13637.3
945	125	5	105	60	20	0.045	30	1509	141	1351	0.96	0.01	0.02	29496.3	1903.0	-61685.9	27061.6
999	125	5	105	60	20	0.045	30	1731	749	520	0.73	0.02	0.26	33842.5	10128.6	-23752.9	18538.3
1000	125	5	105	60	20	0.045	30	1956	440	604	0.41	0.59	0.00	38238.4	5953.7	-27581.8	19187.8

Expected profit = Average (overall expected profit) = Rs. 12349.55

For summer season (table 2), major problem for the wholesaler is the limited shelf life of eggs. Also the demands are less. Therefore it is better to stock at a level where losses can be reduced and chances for losses are minimized. One such scenario can be seen in table 2.

Table 2 : summarized results for summer season

SHL-15 days							
N	d	t	Average	Max	Min	Positive	Negative
1000	5%	8	3477.3	8965.6	-9256.3	83.6%	16.4%
		10	3281.1	8926.8	-9487.3	83.5%	16.5%
	10%	8	3694.8	8973.3	-7367.3	84.5%	15.5%
		10	3261.0	8939.6	-9104.1	84.5%	15.5%
	15%	8	3807.2	8965.5	-7411.1	84.8%	15.2%
		10	3677.2	8939.8	-9001.1	78.5%	21.5%
2000	5%	8	3515.5	17219.9	-31465.4	74.2%	25.8%
		10	3716.7	17626.5	-31468.1	72.5%	27.5%
	10%	8	3370.4	17178.3	-29925.6	71.2%	28.8%
		10	3159.0	17300.5	-36712.2	72.7%	27.3%
	15%	8	2979.4	17794.6	-30609.8	66.3%	33.7%
		10	2979.4	17216.2	-30505.5	67.1%	32.9%
3000	5%	8	3557.4	25445.5	-69030.3	70.3%	29.7%
		10	2618.3	25820.3	-61678.9	68.2%	31.8%
	10%	8	2658.2	25459.0	-51131.2	66.2%	33.8%
		10	2922.2	26237.4	-61770.0	65.5%	34.5%
	15%	8	1753.3	25868.8	-52024.0	63.5%	36.5%
		10	1753.3	26304.8	-55396.9	66.6%	33.4%
4000	5%	8	3995.3	35289.4	-74373.2	66.8%	33.2%
		10	4728.9	35087.7	-88833.2	68.0%	32.0%
	10%	8	2515.7	34680.8	-79402.2	64.4%	35.6%
		10	2781.0	34142.0	-76772.3	64.6%	35.4%
	15%	8	957.7	34116.8	-83055.6	61.9%	38.1%
		10	957.7	34141.5	-82286.9	61.9%	38.1%
0%	8	4327.3	35547.3	-65704.2	69.6%	30.4%	

For n=1000, d=15% and t= 8th day, we can see that the wholesaler's average profit is maximum Rs. 3807.2 with a positive profit chance of 84.8%. Also the losses are not high in this case. Another close scenarios are when (n,d,t); (3000, 0, 0) and (4000, 5%, 10). In both these cases, first inventory is quite high, which involves stocking, distribution cost along with additional sale requirement. Also, positive profit chances for both the cases are 67.8% and 68.0% respectively. Also the loss incurred is huge. Therefore, in summer season, where the wholesaler do not have large shelf life, the best possible combination for number of units to be stocked, quantum of discount and time of discount will be n=1000, d=15% and t=8th day.

For winter season (table 3), due to the enhanced shelf life of the egg, it is easier for the

wholesaler to stock more and more. Since at n=3000, d=5% and t=20 days, we see that average profit comes out to be Rs. 13349.50. The chances of maximum profit will be Rs. 39883.3 and maximum loss will be Rs. 48167.40. Close to the highlighted figure (table 3), are (n,d,t); (3000, 5%, 25) , (4000, 5%, 20), (5000, 5%, 20) and (5000, 5%, 25). But, as we can see, the minimum value of profit are quite high and chances of profit are also low when compared to (3000, 5%, 20). Same is the case with inventory for 4000 units and 5000 units. Additionally such large inventory will require more marketing, sales, distribution, storage etc. which will inculcate extra cost and pressure on the wholesaler. Therefore, in winter season, where the wholesaler has the liberty of having shelf life of 30 days, the best possible combination for number of units to be stocked,

quantum of discount and time of discount will be n=3000, d=5% and t=20 days. Another interesting fact is, the average profit at n=5000, d=0% and t=0% is Rs. 15643.6, see that the difference of maximum and minimum values of profit is quite large. Also the

probable chances of having profits are 68% approx which is quite less as compared to the optimum scenario. Hence it is not a wise decision for wholesaler to carry on with large amount of eggs with lower discounts.

Table 3 : summarized results for winter season

SHL 30 days							
n	d	t	Average	Max	Min	Positive	Negative
2000	5%	20	10743.3	27317.7	-23215.1	85.6%	14.4%
		25	10664.4	27187.3	-18135.6	85.6%	14.4%
	10%	20	10181.8	27367.6	-25727.2	83.0%	17.0%
		25	10949.2	27204.1	-20641.8	85.0%	15.0%
	15%	20	10188.2	27366.7	-22156.4	83.2%	16.8%
		25	10010.3	27185.2	-20995.3	81.7%	18.3%
	20%	20	9767.7	27319.6	-24218.4	80.1%	19.9%
		25	9503.8	27156.7	-24185.3	79.5%	20.5%
0%	0	12500.4	27978.5	-22544.6	78.6%	21.4%	
3000	5%	20	12349.6	39883.4	-48167.4	81.9%	18.1%
		25	12371.4	40370.6	-56939.6	79.6%	20.4%
	10%	20	10659.3	39883.9	-50554.5	75.9%	24.1%
		25	10885.4	40033.6	-50212.4	78.1%	21.9%
	15%	20	9225.3	39879.9	-56468.4	73.1%	26.9%
		25	10508.6	40475.3	-52228.7	75.7%	24.3%
	20%	20	9195.4	39814.3	-57762.1	71.1%	28.9%
		25	8882.9	39426.9	-53108.5	71.0%	29.0%
	0%	0	11725.7	41841.7	-51959.2	81.7%	18.3%
4000	5%	20	13110.3	51731.0	-86997.6	77.9%	22.1%
		25	12071.3	51998.9	-96941.4	78.1%	21.9%
	10%	20	11255.6	53314.9	-76796.5	74.2%	25.8%
		25	11241.7	52695.9	-71507.1	74.0%	26.0%
	15%	20	11287.0	53193.9	-71803.8	71.1%	28.9%
		25	9017.2	52610.9	-77089.1	70.8%	29.2%
	20%	20	9287.5	52426.0	-86394.9	65.5%	34.5%
		25	8875.0	53731.1	-66793.3	65.8%	34.2%
0%	0	14085.7	52667.0	-75976.3	78.6%	21.4%	
5000	5%	20	13851.6	67443.9	-100192.1	76.3%	23.7%
		25	13349.0	66388.0	-125088.0	74.6%	25.4%
	10%	20	11159.8	67021.2	-127490.4	69.4%	30.6%
		25	11555.9	66342.9	-138294.2	73.0%	27.0%
	15%	20	10419.6	66892.0	-94364.0	69.8%	30.2%
		25	8078.5	64527.9	-134126.7	67.1%	32.9%
	20%	20	7742.7	67230.5	-116428.5	63.3%	36.7%
		25	7789.7	66466.4	-104897.1	66.1%	33.9%
0%	0	15643.6	68940.4	-122490.0	67.9%	32.1%	

VI. CONCLUSIONS AND FUTURE RESEARCH DIRECTION

The simple expected profit calculation procedure depicted in this study could be utilized at least for two reasons. The first reason might be to compare a discount policy with a no-discount policy. In table 2 and table 3, for example, we can easily make a decision in favor of applying a discount policy instead of a no-discount policy. Another reason could be to evaluate several different discount rate combinations and/or various discount schedules for a number of crates need to be ordered. As we can see from the result table that offering discount is somehow better than not offering discounts in both seasons. Although in some cases no large difference in revenue is there between zero and some discount offered by the wholesaler, but the chances of profit/ loss also effects the decision. On the other hand, when they are implemented in the right manner, price discounts offered for eggs in both seasons have their own benefits like reduction of waste; shortening the cycle time for the item inventories and thus, more space availability for the fresh products; and reduction of the holding costs.

Hence, there appears to be a tradeoff between the benefits of perishable product discount pricing and the costs linked with the challenging full-priced perishable products. Achieving a well-balanced pricing approach will require information regarding the characteristics of the specific market, including the percentage of waste of perishable products, the proportion of discounted perishable products, and the customers who wait for the discounts (which are price sensitive). Only with such information, the true impact of perishable item discount pricing on the demands of other products could be determined.

For future research, more trials can be performed in order to reduce the chances of errors. Cost of waste can also be inculcated in the equation. Other factors such as producer's risk and consumer's risk can also have an effect on the overall performance of wholesaler. Also other factors effecting demand such as economic, demographic etc. can be taken care of for future research.

REFERENCES RÉFÉRENCES REFERENCIAS

1. Abad, P.L. (2001). Optimal price and order size for a reseller under partial backordering, *Computers & Operations Research* 28 53–65.
2. Abad, P.L. (2003). Optimal pricing and lot-sizing under conditions of perishability, finite production and partial backordering and lost sale. *European Journal of Operational Research* 144 677–685.
3. Akcay, Y., Natarajan, H.P., Xu, S.H. (2010), Joint dynamic pricing of multiple perishable products under consumer choice, *Management Science* 56 (8) 1345– 1361.
4. Arcelus, F.J., Shah, N.H., Srinivasan, G. (2003). Retailers pricing, credit and inventory policies for deteriorating items in response to temporary price/credit incentives, *International Journal of Production Economics* 153–162.
5. Berk, E., Gurler, U., Yildirim, G. (2009). On pricing of perishable assets with menu costs, *International Journal of Production Economics* 121 (2) 678–699.
6. Bisi, A. and Dada, M. (2007). Dynamic learning, pricing, and ordering by a censored newsvendor, *Naval Research Logistics* 54 (4) 448–461.
7. Cai, X., Chen, J., Xiao, Y., Xu, X. (2009), Optimization and coordination of fresh product supply chains with freshness-keeping effort, *Production and Operations Management* 19 (3) 261–278.
8. Chang, H.J., Lin, W.F., Ho, J.F. (2011). Closed-form solutions for Wee's and Martin's EOQ models with a temporary price discount, *International Journal of Production Economics* 131 (2) (2011) 528–534.
9. Chew, E.P., Lee, C., Liu, R. (2009). Joint inventory allocation and pricing decisions for perishable products, *International Journal of Production Economics* 120 (1) 139–150.
10. Donselaar, K. van, Woensel, T. van, Broekmeulen, R., Fransoo, J. (2006). "Inventory control of perishables in supermarkets", *Int. J. Production Economics* 104, 462–472.
11. Ferguson, M.E. and Koenigsberg, O. (2009). How should a firm manage deteriorating inventory?, *Production and Operations Management* 16 (3) 306–321.
12. Goyal, S.K. and Giri, B.C. (2003), "The production-inventory problem of a product with time varying demand, production and deterioration rates", *European Journal of Operational Research*, Vol. 147, pp. 549-57.
13. Gupta, Y., Sundararaghavan, P.S. and Ahmed, M.U. (2003), "Ordering policies for items with seasonal demand", *International Journal of Physical Distribution & Logistics Management*, Vol. 33 No. 6, pp. 500-518.
14. Gurler, U. and Yuksel Ozkaya, B. (2003), A note on continuous review perishable inventory systems: models and heuristics, *IIE Transactions* 35 (3) 321–323.
15. Hahn, K.H., Hwant, H. and Shinn, S.W. (2004), "A returns policy for distribution channel coordination of perishable items", *European Journal of Operational Research*, Vol. 152, pp. 770-80.
16. Krishnan, H. and winter, R.A. (2010). Inventory dynamics and supply chain coordination, *Management Science* 56 (1), 141–147.
17. Li, Y., Cheang, B., Lim, A. (2011), *Grocery Perishables Management*, *Production and Operations Management*.

18. Li, Y., Lim, A., Rodrigues, B. (2008), Pricing and inventory control for a perishable product, *Manufacturing & Service Operations Management* 11 (3) 538–542.
19. Lin, Y.S., Yu, J.C.P., Wang, K.J. (2009). An efficient replenishment model of deteriorating items for a supplier–buyer partnership in hi-tech industry, *Production Planning & Control* 20 (5) 431–444.
20. Ramanathan, R. (2006), Stocking and discounting decisions for perishable commodities using expected profit approach, *International Journal of Retail & Distribution Management* 34 (2) 172–184.
21. Sezen, B. (2004), Expected profit approach used in discount pricing decisions for perishable products, *International Journal of Retail & Distribution Management*, Vol. 32 No. 4, pp. 223-9.
22. Teng, J.T., Ouyang L.Y., Chen, L.H. (2007). A comparison between two pricing and lot-sizing models with partial backlogging and deteriorated items, *International Journal of Production Economics* 105 (1) 190–203.
23. Tsao, Y.C. and Sheen, G.J. (2007). Joint pricing and replenishment decisions for deteriorating items with lot-size and time-dependent purchasing cost under credit period, *International Journal of Systems Science* 38 (7) 549–561.
24. Tsao, Y.C., Sheen, G.J., (2008). Dynamic pricing, promotion and replenishment policies for a deteriorating item under permissible delay in payments, *Computers & Operations Research* 35 (11) 3562–3580.
25. Vlachos, D. and Dekker, R. (2003), Return handling options and order quantities for single period products, *European Journal of Operational Research*, Vol. 151, pp. 38-52.
26. Warburton, R.D.H., (2009). EOQ extensions exploiting the Lambert W function, *European Journal of Industrial Engineering*. 3 (1) 45.