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Optimal Policies for Deteriorating Items with Preservation and Maintenance Management When Demand is Trade Credit Sensitive

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Abstract

This paper is an attempt to model integrated inventory system consisting of single manufacturer, single retailer dealing with constantly deteriorating item. In order to control the rate of deterioration retailer invests in preservation and maintenance management. Manufacturer offers a trade credit period to the retailer with an agreement that retailer has to share fraction of profit earned during this credit period. Retailer also extends partial trade credit period to the end customers to boost the demand. The objective of this paper is to maximize the total joint profit of manufacturer and retailer with respect to cycle time, credit period and preservation technology investment. Numerical examples are given to validate the model and sensitivity analysis of inventory parameters is done to understand their effect. Outcome of this paper is applicable to fast moving goods like Electronic gadgets, Fashion accessories, Clothing, Footwear, fruits, vegetables and dairy products etc.

Key words

Deterioration, integrated model, permissible delay, preservation technology investment, profit sharing contract.

1. Introduction

Offering permissible delay in payment acts as a promotional tool to boost the sales. In real market, retailers usually do not need to pay the total amount when the products are received; they are allowed delay in payment by suppliers. This type of permissible delay is very common in today's business world. For suppliers, offering delay in payment attracts retailer and results increase in sale. For retailers, delay in payment reduces the opportunity cost of capital, but also allows them to earn interest on the revenue generated during the permissible delay period. Hence, trade credit policy is beneficial to both suppliers and retailers. Goyal (1985) first developed an economic order quantity (EOQ) model in which after a fixed delay period was offered after the products were received. Afterwards, Agrawal and Jaggi (1995) proposed inventory models with permissible delay in payment. Refer Chang et al. (2008) and Shah et al. (2010) for a complete review of trade credit in inventory models. Sarkar (2012) discussed an inventory model that allow delay in payments in presence of imperfect production. Giri and Maiti (2013) formulated model with price and trade credit sensitive demand in which retailer borrows loan from bank to settle the accounts. All of the above mentioned papers discussed the issue from the perspective of the supplier or the retailer, and just focused on one sided optimal strategies.

Many inventory model follow an assumption that only retailer gets trade credit from the supplier. However in business transaction retailer also extends this credit period to the end customer which helps in accelerating demand. Huang (2003) developed an EOQ model in which the retailer gets benefited if the credit period which is received from the supplier is passed onto the end customers. The economic order quantity is computed when the supplier offers the retailer a credit period M and the retailer passes on credit period N to the customers with $N<M$. This scenario is known as two-level trade credit. Teng and Chang (2009) analyzed the two level trade credit by relaxing the assumption $N<M$. Some relevant papers related to the two-level trade credit policy are Min et al. (2010), Kumar et al. (2011) and Shah et al. (2014).

At present there is a tough competition to survive in market, members of supply chain must integrate their business to enhance their efficiency, satisfying customers more efficiently and lowering the inventory cost. In a non-integrated supply chain, players have different motive, the objective of the supplier or retailer may conflict the objective of the supply chain. When the decision of supply chain are inconsistent or non-coordinated, the supply chain will lose its competitive advantage. Goyal (1976) first developed an integrated inventory model to determine the optimal joint inventory policy for a single supplier and a single retailer. Abad and Jaggi (2003) combined the concept of an integrated inventory model and trade credit policy, and established a supplier–retailer integrated system in which the supplier offers trade credit to the retailer. Afterward, integrated inventory model with various trade credit policies can be found in Su et al. (2007) and Ho et al. (2008).

It has been observed that when a new product is introduced to the market its demand increases following linear trend, with time after reaching its peak the demand falls, which is expressed as quadratic demand. Shah (2015) formulated an integrated inventory model for three players dealing with deteriorating item and quadratic demand rate. Shah and Chaudhari (2015) also formulated an integrated inventory model for three players dealing with deteriorating item with fixed lifetime and demand rate quadratically decreasing and credit period dependent. An inventory model in which two level trade credit with an agreement of profit sharing is found in Shah (2015). Mishra and Shaikh (2017) formulated a two warehouse integrated inventory model for stock dependent demand rate with order size dependent trade credit.

Deterioration of items is an important concern for any firm, it is inevitable and plays an important role as utility of item gets affected. To control the deterioration rate investments are made in preservation technology. Many researchers have formulated models for controlling deterioration by investing in preservation technology. Ghare and Schrader (1963) developed the first EOQ model for inventory following exponential decay. Hariga (1995) Developed EOQ model for deteriorating items with shortages and time varying demand. Jaggi and Mittal (2007) developed EOQ model for deteriorating items with time dependent demand under inflationary conditions. Shah and Mishra (2010) developed inventory model for deteriorating items with salvage value under retailer partial trade credit and stock-dependent demand in supply chain. Jaggi and Mittal (2011) developed an EOQ model for deteriorating items with imperfect quality. Shah et al. (2014) studied optimal pricing and ordering policies for deteriorating items with two-level trade credits under price-sensitive trended demand. Shah and Jani (2016) formulated EOQ model for non-Instantaneously deteriorating items under order-size-dependent trade credit for price-sensitive quadratic demand. Sarkar et al. (2016) presented a model for preservation of deteriorating seasonal products with stock-dependent demand. Mishra et al. (2017) developed an EOQ model with price sensitive stock dependent demand with shortages. Shah et al. (2017) presented an imperfect manufacturing system with quadratic demand under inflation.

In this paper we propose an integrated inventory model with manufacturer and retailer as member of supply chain. Retailer's demand is quadratic and sensitive to permissible delay period, inventory items are deteriorating in nature. To control this deterioration rate investment is made in preservation and maintenance management. Manufacturer offers credit period to the retailer with an agreement that retailer has to share fraction of profit during this credit period. The objective of this paper is to maximize the joint total profit of the chain with respect to optimal cycle time, trade credit offered by retailer to end customer and optimal preservation technology investment. Joint as well as individual profits of players are studied to get feasibility of a long term sustainable supply chain. The rest of the paper is arranged in this manner. In section 2, notations and assumptions are presented. In Section 3, the mathematical model to maximize joint total profit per unit time is presented along with solution procedure. Section 4 contains numerical example and section 5 has sensitivity analysis of inventory parameters. Lastly conclusion is drawn in section 6.

2. Notation and Assumptions:

The proposed model uses the following notation and assumptions.

2.1 Notation

Inventory Parameters for retailer

C_r Retailer's unit purchase cost

h_r Holding cost per annum

A_r Retailer's ordering cost per order

S Retailer unit selling price, $S > C_r$

θ Constant deterioration rate, $0 \le \theta < 1$

N Credit period offered to end customer by retailer

α Mark up for credit period (N)

δ Fraction of profit shared with manufacturer during the credit period; $0 \le \delta < 1$

I_b Interest rate on the loan borrowed from bank

I_e Interest earned rate by the retailer

γ Fraction of customer permitted by retailer to pay with a trade credit period N

$I_r(t)$ Inventory level with retailer at time t.

π_r Retailer total profit per unit time

$f(u)$ $= 1 - \dfrac{1}{1+\mu u}$; Proportion of reduced deterioration of item

Inventory Parameters for manufacturer

A_m Manufacture setup cost per lot

C_m Manufacturing cost of item per unit, $C_m < C_r$

h_m Holding cost per annum

M Credit period retailer gets from the manufacturer

I_m Interest rate loss by manufacturer due to offering of trade credit

T_m $= xT$; Time delay for manufacturer to start the production, $(0 < x < 1)$

$I_m(t)$ Inventory level with manufacturer at time t.

π_m Manufacturer total profit per unit time

Decision variables

u Investment in preservation technology

N Credit period offered to end customer by retailer

T Replenishment cycle time

Relation between inventory parameters

$N \le M$

$S > C_r > C_m$

$0 \le \theta < 1$

Functions

$D(N,t)$ Trade credit sensitive quadratic demand rate; $D(N,t) = a(1+bt-ct^2)N^\alpha$, where $a > 0$ scale demand, $b > 0$ linear rate of change of demand, $0 < c < 1$ quadratic rate of change of demand and $\alpha > 0$ is mark up for downstream trade credit.

$P(N,t)$ Finite production rate proportional to demand rate, $P(N,t) = \eta D(N,t), \eta > 1$.

$\pi(u,N,T)$ Total profit of supply chain $(\pi_m + \pi_r)$

The objective of the integrated supply chain is expressed as follows:

Max $\pi(u,N,T)$

Subject to, $\begin{array}{l} N \le M, \\ u,N,T \ge 0 \end{array}$

2.2 Assumptions

1) Inventory system consist of single manufacturer, single retailer dealing with single item.
2) The demand rate, $D(N,t) = a(1+bt-ct^2)N^\alpha$ of retailer is trade credit sensitive quadratic demand. In this model $D(t)$ and D are used interchangeably for notational convenience.
3) Production rate $P(N,t)$ of manufacturer is greater than the demand rate $D(N,t)$ of retailer. Which indicates manufacturer has sufficient production capacity to meet the demand of retailer.
4) Manufacturer offers a credit period M to retailer with an agreement that retailer has to share fraction of profit earned with the manufacturer during this credit period.
5) If the cycle time exceeds the manufacturer's credit period, the retailer has to pay the

purchase cost of item from the rest of his sales revenue. But, retailer do not sufficient fund to settle the accounts. So, he takes a loan from a bank at the end of the credit period M at an interest rate I_b to pay the manufacturer the rest of the purchase cost. Retailer repay the loan to the bank at the end of the cycle time.

6) During the credit period manufacturer incurs an interest loss at the rate of I_m. Further, retailer earns interest on generated revenue at the rate of I_e by depositing his revenue in some interest bearing account.
7) The retailer provides only a partial trade credit period $N < M$ to the end customers.
8) The proportion of reduced deterioration rate $f(u)$, is assumed to be a continuous increasing and concave function of investment u on preservation technology, i.e. $f'(u) > 0$ and $f''(u) < 0$. Also $f(0) = 0$, in this model $f(u)$ and f are used interchangeably for notational convenience.
9) Planning horizon is infinite to boost a long term relationship among supply chain players.
10) Lead time is zero. Shortages are not allowed.

3. Mathematical Model

3.1 Retailer's Total Profit Per Unit Time

In the proposed model, retailer's inventory level $I_r(t)$ depletes with respect to demand D and deterioration of inventory items, therefore $\theta I_r(t)$. The deterioration of inventory items is controlled by investing in preservation technology, therefore $\theta f\, I_r(t)$. Thus, retailer's inventory level at any time t is governed by the following differential equation:

$$\frac{dI_r(t)}{dt} + \theta(1-f)I_r(t) = -a(1+bt-ct^2)N^{\alpha}, \quad 0 \le t \le T \tag{1}$$

with $I_r(0) = Q$ and $I_r(T) = 0.$ The solution of (1) using $I_r(T) = 0$ is,

$$I_r(t) = aN^{\alpha}\left[\begin{array}{l} e^{\theta(1-f)(T-t)}\left(\dfrac{1+bT-cT^2}{k} - \dfrac{b-2cT}{k^2} - \dfrac{2c}{k^3}\right) \\ -\left(\dfrac{1+bt-ct^2}{k} - \dfrac{b-2ct}{k^2} - \dfrac{2c}{k^3}\right) \end{array}\right] \tag{2}$$

Using the other condition $I_r(0) = Q$ and (2), we have

$$Q = aN^{\alpha}\left[e^{\theta(1-f)(T)}\left(\frac{1+bT-cT^2}{k}-\frac{b-2cT}{k^2}-\frac{2c}{k^3}\right)-\left(\frac{1}{k}-\frac{b}{k^2}-\frac{2c}{k^3}\right)\right] \tag{3}$$

The costs relevant to retailer's total profit are as follows

- Sales revenue generated, $SR_r = S\left[\int_0^T (a(1+bt-ct^2)N^{\alpha})dt\right]$
- Purchase cost, $PC_r = C_rQ$
- Ordering cost, $OC_r = A_r$
- Investment in preservation technology, $IPT = u$
- Holding cost, $HC_r = h_r\left[\int_0^T I_r(t)dt\right]$

Next, depending on the values of credit period M and N offered by manufacturer to retailer and retailer to end customer, and cycle time T . The following three cases to arise (i) $N \le M \le T$, (ii) $N \le T \le M$ and (iii) $T \le N \le M$. Next we discuss each of them in detail

Case I: $N \le M \le T$

During $[0, M]$, as per the agreement retailer gives $\delta\%$ of the profit to the manufacturer. So the fraction of profit shared is, $FP_1 = \delta(S - C_r)\int_0^M (a(1+bt-ct^2)N^{\alpha})dt$ and the remaining can be used to settle the accounts. To settle the accounts at the end of credit period (M) retailer takes loan from the bank at the rate of I_b per annum and pays it back at the end of cycle time. So the interest charged by bank is,

$$ICB_r = I_b\left[C_r\int_0^T (a(1+bt-ct^2)N^{\alpha})dt - S\int_0^M (a(1+bt-ct^2)N^{\alpha})dt + FP_1\right](T-M) \tag{4}$$

Interest earned by the retailer during the cycle time is,

$$IE_{r1} = I_eS\left[\int_0^M (a(1+bt-ct^2)N^{\alpha}t)dt + \int_0^{T-M} (a(1+bt-ct^2)N^{\alpha}t)dt\right] \tag{5}$$

Also retailer's opportunity loss due to offering partial credit period N is,

$$OL_{r1} = \gamma I_e S\left[\int_0^N (a(1+bt-ct^2)N^{\alpha}t)dt\right] \tag{6}$$

Therefor the retailer's total profit per unit time is given by,

$$\pi_{r1} = \frac{1}{T}\left(SR_r - PC_r - OC_r - HC_r - FP_1 - ICB_r - OL_{r1} + IE_{r1}\right) - IPT \tag{7}$$

Case II: $N \le T \le M$

The fraction of profit shared is, $FP_2 = \delta\left(S - C_r\right)\int_0^T (a(1+bt-ct^2)N^{\alpha})dt$ and the interest earned by the retailer during the cycle time is,

$$IE_{r2} = I_e S\left[\int_0^T (a(1+bt-ct^2)N^{\alpha}t)dt + Q\left(M-T\right)\right] \tag{8}$$

Also retailer's opportunity loss during $\left[0, N\right]$ is,

$$OL_{r2} = \gamma I_e S\left[\int_0^N (a(1+bt-ct^2)N^{\alpha}t)dt\right] \tag{9}$$

Here the retailer has sufficient fund to settle the accounts, so there is no need of taking loan from the bank. Therefore the retailer's total profit per unit time is given by,

$$\pi_{r2} = \frac{1}{T}\left(SR_r - PC_r - OC_r - HC_r - FP_2 - OL_{r2} + IE_{r2}\right) - IPT \tag{10}$$

Case III: $T \le N \le M$

Here the fraction of profit shared is same as in case II, $FP_2 = \delta\left(S - C_r\right)\int_0^T (a(1+bt-ct^2)N^{\alpha})dt$

and the interest earned by the retailer during the cycle time is,

$$IE_{r3} = I_e S\left[\int_0^T (a(1+bt-ct^2)N^\alpha t)dt + Q(M-T)\right] \tag{11}$$

Also offering credit period to end customer retailer incurs opportunity loss during $[0, N]$ which is given by,

$$OL_{r3} = \gamma I_e S\left[\int_0^N (a(1+bt-ct^2)N^\alpha t)dt + Q(N-T)\right] \tag{12}$$

In this case also the retailer has sufficient fund to settle the accounts, so there is no need of taking loan from the bank. Therefore the retailer's total profit per unit time is given by,

$$\pi_{r3} = \frac{1}{T}\left(SR_r - PC_r - OC_r - HC_r - FP_2 - OL_{r3} + IE_{r3}\right) - IPT \tag{13}$$

3.2 Manufacturer Total Profit Per Unit Time

In the proposed model, manufacturer inventory level $I_m(t)$ at any time t is governed by the following differential equation:

$$\frac{dI_m(t)}{dt} = P(N,t) - D(N,t), \quad T_m \le t \le T \tag{14}$$

with $I_m(T) = 0.$ The solution of (14) using this condition is,

$$I_m(t) = aN^\alpha(\eta - 1)\left[\left(t + \frac{bt^2}{2} - \frac{ct^3}{3}\right) - \left(T + \frac{bT^2}{2} - \frac{cT^3}{3}\right)\right] \tag{15}$$

The manufacturer total profit per unit time consist of sales revenue, production cost, setup cost, holding cost and opportunity loss.

- Setup cost, $OC_m = A_m$

- Holding cost, $HC_m = h_m \left[\int_{T_m}^{T} I_m(t)dt \right]$
- Interest loss occurred for offering trade credit M to retailer,
-

$$OL_m = I_m C_r M \left[\int_{T_m}^{T} \eta(a(1+bt-ct^2)N^\alpha)dt \right] \tag{16}$$

Under the contract manufacturer receives $\delta\%$ of the profit earned by the retailer during the credit period. So the fraction of profit gained by manufacturer is given by,

$$FP_m = \begin{cases} FP_{m1} = \delta\left(S - C_r\right)\int_0^M (a(1+bt-ct^2)N^\alpha)dt, M \le T \\ FP_{m2} = \delta\left(S - C_r\right)\int_0^T (a(1+bt-ct^2)N^\alpha)dt, M > T \end{cases} \tag{17}$$

Therefore the manufacturer total profit per unit time is given by

$$\pi_{m1} = \frac{1}{T}\left[\left(C_r - C_m\right)\int_0^T (a(1+bt-ct^2)N^\alpha)dt - OC_m - HC_m - OL_m + FP_{m1} \right], M \le T \tag{18}$$

$$\pi_{m2} = \frac{1}{T}\left[\left(C_r - C_m\right)\int_0^T (a(1+bt-ct^2)N^\alpha)dt - OC_m - HC_m - OL_m + FP_{m2} \right], M > T \tag{19}$$

3.3 Joint Profit of Supply Chain

The objective is to maximize the joint total profit per unit time of integrated chain consisting of manufacturer and retailer which is a multivariate function of partial trade credit, preservation technology investment and cycle time. Depending upon the duration of credit period and cycle time, total profit of supply chain is as follows:

$$\pi(u,N,T) = \begin{cases} \pi_1(u,N,T) = \pi_{r1} + \pi_{m1}, N \le M \le T \\ \pi_2(u,N,T) = \pi_{r2} + \pi_{m2}, N \le T \le M \\ \pi_3(u,N,T) = \pi_{r3} + \pi_{m2}, T \le N \le M \end{cases} \tag{20}$$

In this model joint total profit of the manufacturer and retailer is to be maximized with respect to preservation technology investment and cycle time.

Next, we follow the following steps listed below to have an optimal solution.

Algorithm

Step 1: Assign numerical values to all the inventory parameters.

Step 2: Set $\frac{\partial \pi_i}{\partial u} = 0, \frac{\partial \pi_i}{\partial N} = 0$ and $\frac{\partial \pi_i}{\partial T} = 0, i = 1, 2, 3$ and solve simultaneously for u,N and T.

Find out the appropriate scenario and for that obtained check the sufficiency condition.

4. Numerical Examples

Example 1: Consider

$a = 1000,\ b = 0.1,\ c = 0.2,\ C_m = \$8$ per unit, $C_r = \$15$ per unit, $S = 25$ per unit,
$A_r = \$200$ per order, $h_r = \$2$ per unit per year, $\delta = 0.1,\ \gamma = 0.15,$

$\alpha = 0.004,\ I_b = 11\%$ per annum, $I_e = 10\%$ per annum, $M = 0.4$ year, $\theta = 20\%,\ \mu = 15\%,$
$\eta = 1.3,\ x = 0.01,\ h_m = \$1.5$ per unit per year, $I_m = 10\%$ per annum and $A_m = \$250$ per setup**.**

Here the maximum profit is $\pi_1 = \$15304.34$ for cycle time is $T = 0.5437$ years giving credit period $N = 0.3054$ years to end customers and investing \$68.26 in preservation technology. It represents the scenario $N \le M \le T$ and for the obtained values,

$$\begin{vmatrix} \frac{\partial^2 \pi}{\partial T^2} & \frac{\partial^2 \pi}{\partial T \partial u} & \frac{\partial^2 \pi}{\partial T \partial N} \\ \frac{\partial^2 \pi}{\partial T \partial u} & \frac{\partial^2 \pi}{\partial u^2} & \frac{\partial^2 \pi}{\partial u \partial N} \\ \frac{\partial^2 \pi}{\partial T \partial N} & \frac{\partial^2 \pi}{\partial u \partial N} & \frac{\partial^2 \pi}{\partial N^2} \end{vmatrix} = -3.8677 \times 10^5 < 0,$$

which suggests concavity of profit function. The concavity of the given profit function is shown in the figures 1-3.

Example 2: Consider $M = 0.6$ year, θ=5% and all other parameter same as in example 1. Here the maximum profit is $\pi_2 = \$15227.65$ which comes out for scenario $N \le T \le M$ at $T = 0.4363$ years, $N = 0.3075$ years and $u = 94.77$.

Example 3: Consider $\alpha = 0.012,\ M = 0.6$ year and all other parameter same as in example 1. The scenario $T \le N \le M$ gives maximum profit as $\pi_3 = \$15208.49$ which comes out at

$T = 0.4546$ years, $N = 0.5174$ years and $u = 60.93$.

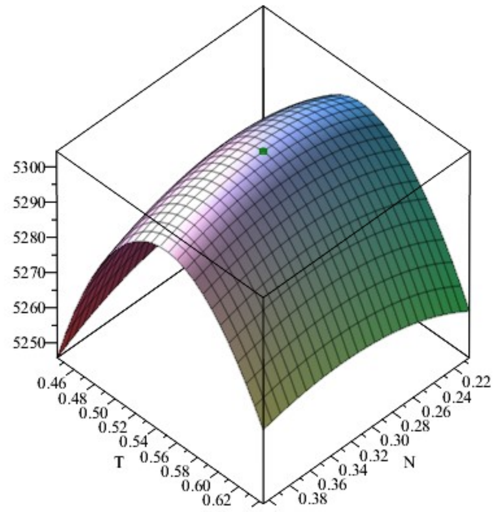

Fig.1. Concavity of Profit Function for $u = 68.26\$$

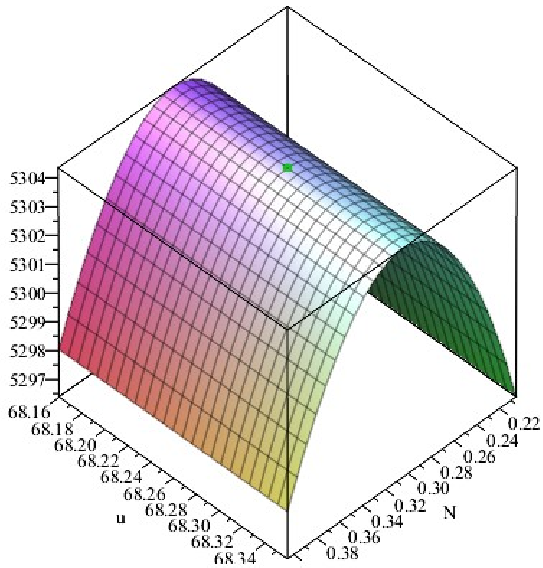

Fig.2. Concavity of Profit Function for $T = 0.5437$ Years

Figure (4) shows the joint and individual profit for the all the three examples, which represent all the possible cases.

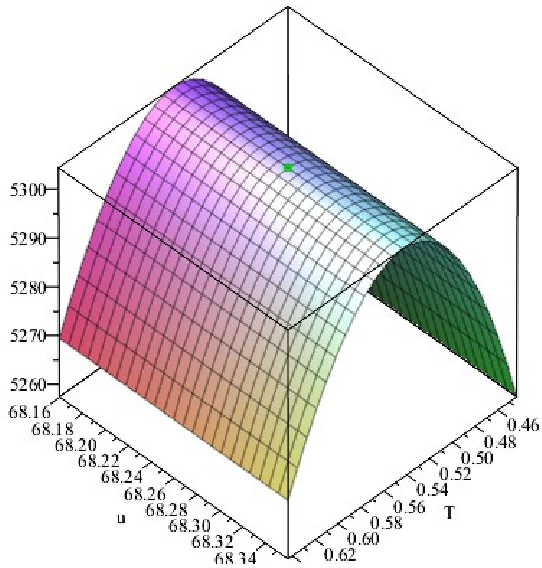

Fig.3. Concavity of Profit Function for $N = 0.3054$ Years

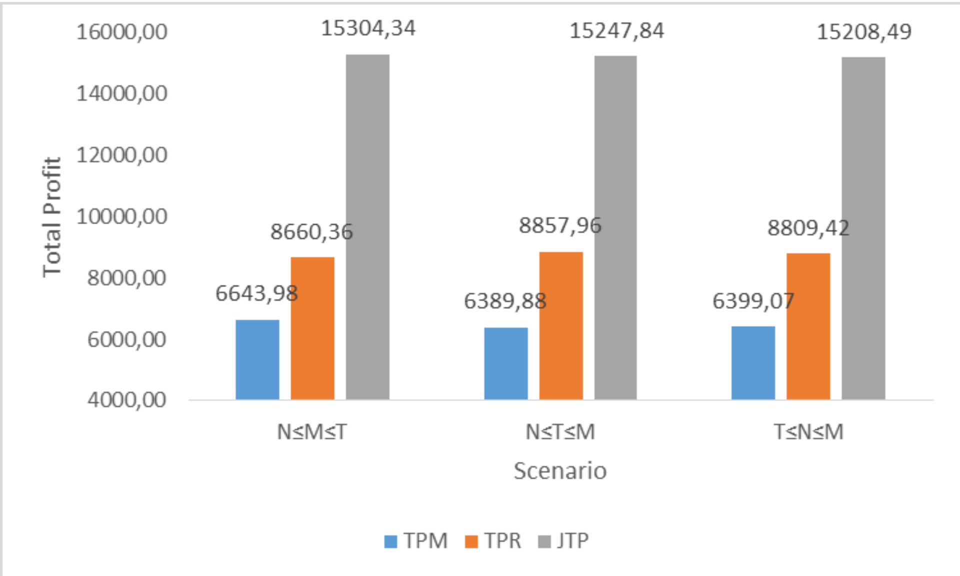

Fig.4. Joint and Individual Profit

5. Sensitivity Analysis

With the values of inventory parameters taken in example 1, sensitivity of inventory parameters is done by changing one parameter at a time by -20%, -10%, 10% and 20% and variation in joint total profit, cycle time and preservation technology investment is noted.

In figure (5), cycle time is plotted for variation in inventory parameters. The major observations made from this calculations are: quadratic rate of change of demand, manufacturer unit cost, retailer ordering cost, credit period offered by manufacturer to retailer, preservation rate, manufacturer holding cost and interest loss rate of manufacturer increases the cycle time slowly. While it increases rapidly with increase in scale demand, selling price of retailer, proportional rate of production and manufacturer setup cost. Whereas cycle time decreases slowly with increase in linear rate of change of demand, fraction of profit shared by retailer, mark up for trade credit, interest rate of bank, retailer interest earn rate, proportion of time delay in production and deterioration rate. A rapid decrease is seen for retailer unit purchase cost and holding cost.

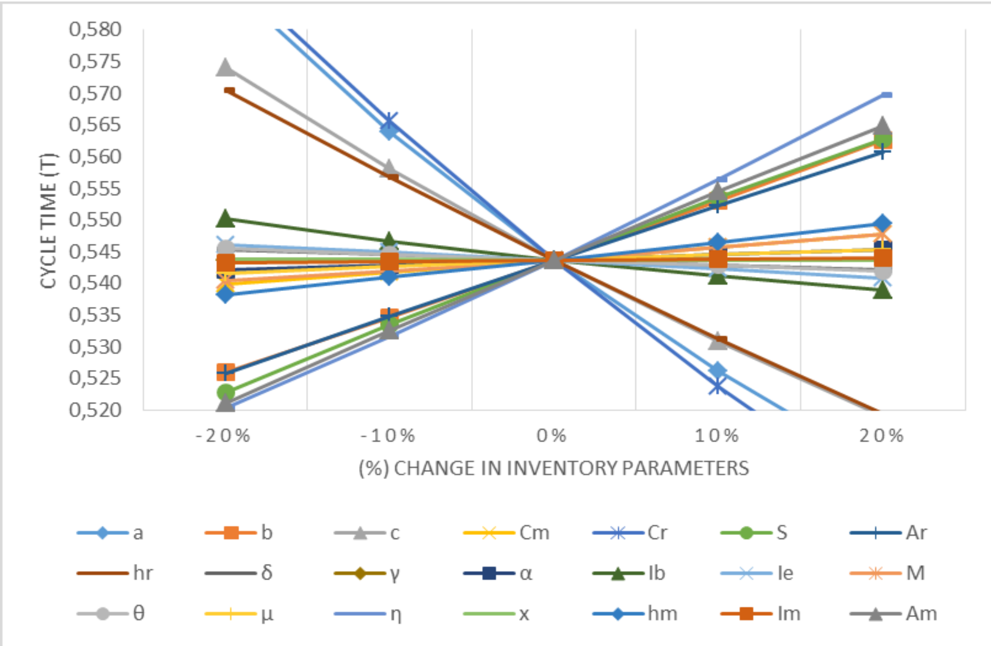

Fig.5. Variation in Cycle Time (T)

Figure (6) is for joint total profit with variation in inventory parameters. It increases slowly with increase in linear rate of change of demand, interest rate of bank, retailer interest earn rate, preservation rate, proportion of time delay in production and manufacturer's holding cost; while it shows a rapid increase with increase in scale demand and retailer's selling price per unit. Quadratic rate of change of demand, ordering cost and holding cost of retailer, fraction of profit shared by retailer, fraction of customer offered trade credit, mark up for trade credit, credit period offered by manufacturer to retailer, deterioration rate, proportional rate of production and manufacturer set up cost decreases the joint total profit. A rapid decrease has been noticed for increase in manufacturer unit cost, retailer unit cost and interest loss rate of manufacturer.

Investment in preservation technology increases rapidly with increase in scale demand, retailer's selling price per unit and deterioration rate. While it decreases rapidly with increase in preservation rate. Changes with respect to other inventory parameters can be observed in figure (7).

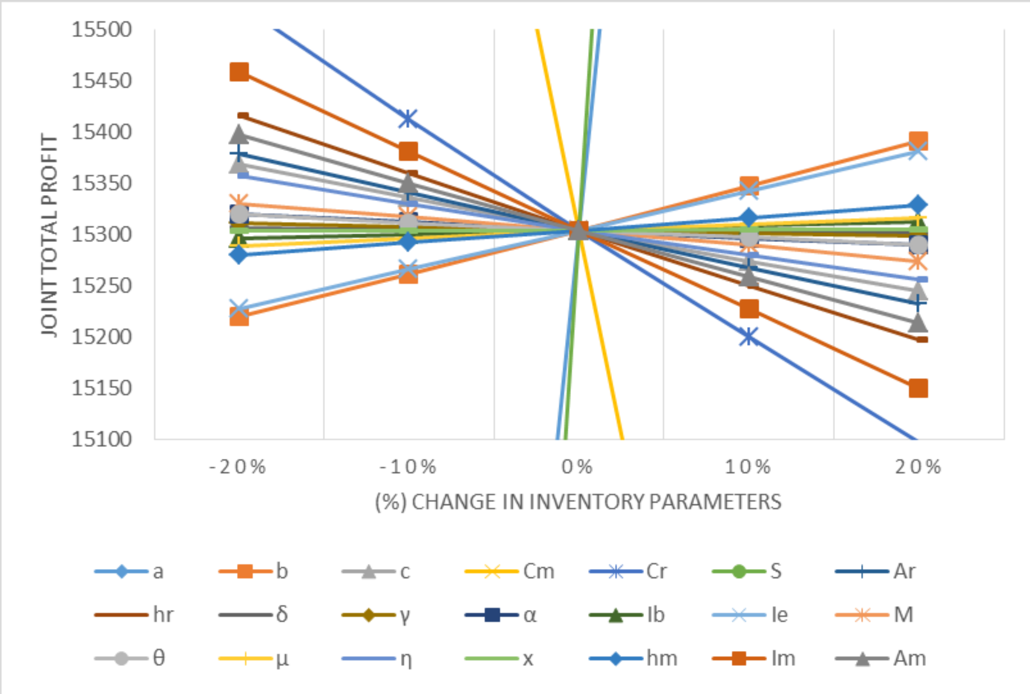

Fig.6. Variation in Joint Total Profit

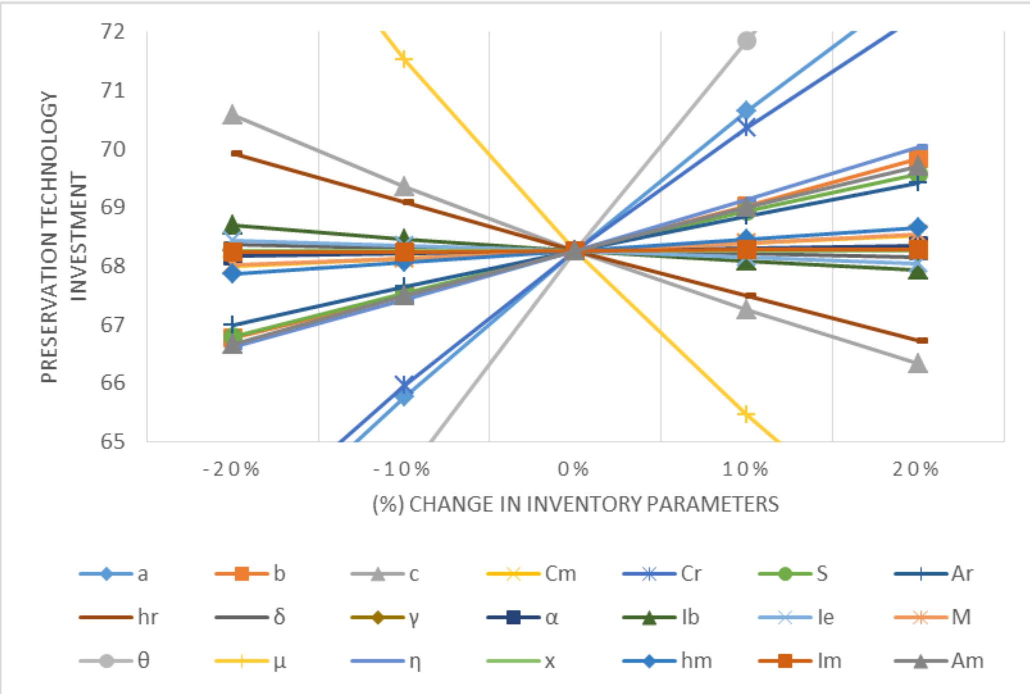

Fig.7. Variation in Preservation Technology Investment (u)

Figure (8) shows that the investment in preservation technology increases with increase in deterioration rate, which clearly shows that increase in deterioration rate increases preservation technology investment. Similar result has been obtained by Shah and Shah (2014) for an EOQ model with stock dependent demand under the effect of inflation.

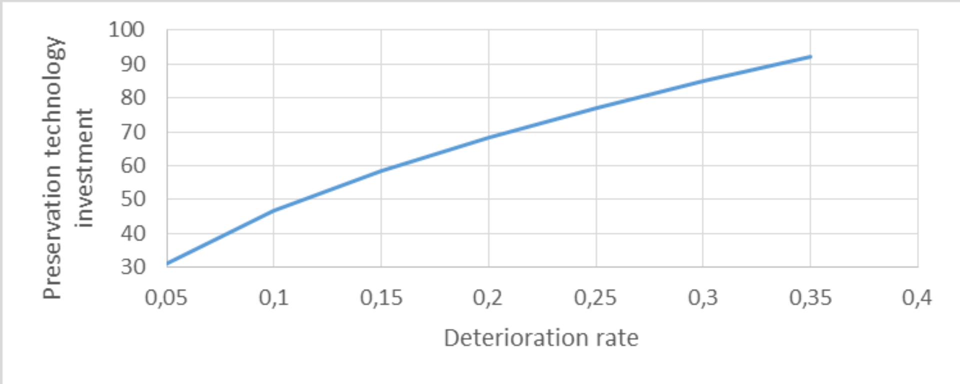

Figure 8: Deterioration rate versus preservation technology investment

Conclusion and Future Research Scope

In this paper we have developed a manufacturer-retailer inventory model for deteriorating items under preservation technology investment. Manufacturer offers a trade credit period to the retailer with an agreement that retailer has to share fraction of profit earned during this credit period. Retailer further extend trade credit to end consumer to accelerate demand. Analysis of model and further results obtained shows that this is a win – win situation for supplier retailer and even end consumer. These policies increase demand and supports long term sustainable supply chain model. Sensitivity analysis shows that joint profit increases with respect to retailer's selling price and scale demand. It also highlights that increase in manufacture's production and retailer's purchase cost has an adverse effect on total joint profit. Balanced and reasonable investment on maintenance and preservation decrease rate of deterioration and hence increases profit.

Further research can be extended in the proposed model by allowing shortages. Effect of inflation on trade credit can also be analyzed.

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