International Journal of Applied Mathematics
and Statistical Sciences (IJAMSS)
ISSN (P): 2319–3972; ISSN (E): 2319–3980
Vol. 10, Issue 2, Jul–Dec 2021; 1–14

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

EFFECTS OF INFLATION AND TRADE CREDIT POLICY ON AN INVENTORY MODEL WITH DETERIORATING AND AMELIORATING ITEMS UNDER EXPONENTIALLY INCREASING DEMAND AND PARTIAL BACKLOGGING

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ABSTRACT

Inflation plays an important role on the traditional economic order quantity model. Any marketing policy depends on inflation due to customer demand and availability of the goods. The present paper deals with an inventory model under inflation, time-value of money and trade credit policy for deteriorating and ameliorating items over a fixed planning horizon. This model is also developed for determining the ordering quantity under the circumstance of time dependent exponentially increasing demand. Shortages are allowed which are partially backlogged. Finally, two examples are given to illustrate the model and the effects of inflation and trade credit policy are also discussed in the present model.

KEYWORDS: *Inventory, Deteriorating, Ameliorating, Inflation, Time-Value of Money, Trade Credit, Exponential Demand and Partial Backlogging*

Subject Classification: *AMS Classification No. 90B05*

Article History

Received: 03 Jul 2021 | Revised: 06 Jul 2021 | Accepted: 09 Jul 2021

INTRODUCTION

Many researchers did not consider the effects of inflation and time-value of money during the development of the economic order quantity models in inventory management system. It may be due to the fact that they did not believe as the inflation would not affect or influence the cost components in the inventory model to any significant degree or low inflation in the economy of the western countries prior to the 1970's. But the last 50 years, there is a rapid change all over the countries and the inflation rate plays an important role in the economy all over. The pioneer in this field was Buzacott [1975], who developed the first inventory model assuming inflation into account. In the same year, Misra [1975] also developed the economic order quantity model considering the inflation. After that several studies have examined the inflationary effect on an inventory policy. In this context, we confined to mention many researchers like Bierman & Thomas[1977], Datta & Pal [1991], Sarkar et al [1994], Bose et al [1995], Kamal Kumar et al [2011], Avikar et al [2012], Bansal [2013],Jaggi et al [2016],Pooja et al [2017], Singh et al [2020] etc.

Most of the inventory model did not have the mathematical development assuming permissible delay in payment or permissible trade credit policy. Here the payment would be made to the buyer for the goods immediately after delivery to the purchaser. In practice, the collaborative business policy in an inventory management system between the venders and the customers is most important and it is found that a buyer allows a certain fixed period of time to settle the account. During this fixed period no interest is charged by the supplier, but beyond this period interest is charged under the terms and conditions agreed upon by the purchaser. When a buyer allows a fixed time period for settling the account, he is actually giving his customer a loan without interest for this period. During this period, the customer can sale the items and continue to accumulate revenue and earn interest instead of paying off the overdraft which may be necessary if the supplier requires settlement of the account immediately after replenishment. The great researchers Goyal [1985] has the first development of the inventory model assuming such trade credit policy. Later Aggarwal and Jaggi [1995] have extended the work of Goyal for items decaying with time. Several researchers like researchers Dye et al [2002], Sing et al [2008], Chang et al [2009], Shon et al [2011], Li et al [2014], Behara et al [2017], Dr. Biswaranjan Mandal [2021] have developed the inventory models assuming such type of trade credit policy.

The ameliorating items are the fast growing animals like broiler, ducks, pigs etc. in the poultry farm, highbred fishes in berry (pond). It is a natural phenomenon observing in much life stock models. Hwang [1997] developed an inventory model for ameliorating items only. Again Hwang [2004] added to a stock model for both ameliorating and deteriorating things independently. Mallick et al. [2018] has considered a creation inventory model for both ameliorating and deteriorating items. Many researchers like Vandana et al[2016], Dr Biswaranjan Mandal [2020] are few noteworthy.

This present study investigates a situation in which five coexist by proposing an inventory model under inflation and time-value of money, trade credit policy, deteriorating and ameliorating items, exponentially increasing demand and shortages with partial backlogging.

Finally, two examples are given to illustrate the model and the effects of inflation and trade credit policy are also discussed in the present model.

Development of the Model

Notations

The Following Notations Are Made:

- q(t): On hand inventory at time t.
- D(t): Demand rate.
- Q: On-hand inventory.
- θ: The constant deterioration rate where $0 \le \theta < 1$
- A: The constant ameliorating rate.
- T: The fixed length of each production cycle.
- i: The inflation rate per unit time.
- r: The discount rate representing the time value of money.
- t_c: Allowable credit period during settling the account.
- A_0: The ordering cost per order during the cycle period.
- p_c: The purchasing cost per unit item.

- h_c : The holding cost per unit item.
- d_c : The deterioration cost per unit item.
- a_c : The cost of amelioration per unit item.
- c_s : The shortage cost per unit item.
- o_c : The opportunity cost per unit item.
- I_e : The interest earned per unit time,
- I_p : The interest paid per unit time,
- OC: Ordering cost per order,
- PC: Purchasing cost over the cycle period
- HC: Holding cost over the cycle period,
- CD: Cost due to deterioration over the cycle period,
- AMC: Amelioration cost over the cycle period,
- CS: Cost due to shortage over the cycle period,
- IP : Total Interest payable over the cycle period,
- IE : Total Interest earned over the cycle period,
- TC: Total average inventory cost per unit time.

Assumptions

The Following Assumptions Are Made:

- Lead time is zero.
- Replenishment rate is infinite but size is finite.
- The time horizon is finite.
- There is no repair of deteriorated items occurring during the cycle.
- Amelioration and deterioration occur when the item is effectively in stock.
- The demand rate is a time dependent exponentially increasing function

  D(t) = $D_0 e^{\lambda t}, D_0 > 0, \lambda \geq 0$.

- Shortages are allowed and they adopt the notation used in Abad [1996], where the unsatisfied demand is backlogged and the fraction of shortages backordered is $e^{-\delta t}$, where δ is a positive constant and t is the waiting time for the next replenishment. We also assume that $te^{-\delta t}$ is an increasing function used in Skouri et al.[2009].

Mathematical Formulation and Solution

The cycle starts with inventory level Q units. The total cycle is divided into two time intervals. During $[0, t_1]$, the stock will be diminished due to the effect of amelioration, deterioration and demand, and ultimately falls to zero at t $= t_1$. In the second time interval $[t_1, T]$, the shortages occur are partially backlogged. The following differential equations pertaining to the above situations are given by

$$\frac{dq(t)}{dt} + (\theta - A)q(t) = -D_0 e^{\lambda t}, 0 \le t \le t_1 \tag{1}$$

And

$$\frac{dq(t)}{dt} = -D_0 e^{\lambda t} e^{-\delta(T-t)}, t_1 \le t \le T \tag{2}$$

The boundary conditions are $q(0) = Q$ and $q(t_1) = 0$ (3)

The solutions of the equations (1) and (2) using (3) are given by the following

$$q(t) = \frac{D_0}{\theta - A + \lambda} e^{\lambda t} \{e^{(\theta - A + \lambda)(t_1 - t)} - 1\},\ 0 \le t \le t_1 \tag{4}$$

$$\text{And } q(t) = \frac{D_0}{\lambda + \delta} e^{\lambda t} e^{-\delta(T-t)} \{e^{(\lambda+\delta)(t_1 - t)} - 1\},\ t_1 \le t \le T \tag{5}$$

Since $q(t_1) = 0$, the equation (4) gives the following

$$Q = \frac{D_0}{\theta - A + \lambda} \{e^{(\theta - A + \lambda)t_1} - 1\} \tag{6}$$

The total inventory holding during the time interval $[0, t_1]$ is given by

$$I_T = \int_0^{t_1} q(t) e^{-Rt} dt = \int_0^{t_1} \frac{D_0}{\theta - A + \lambda} e^{\lambda t} \{e^{(\theta - A + \lambda)(t_1 - t)} - 1\} e^{-Rt} dt, \text{ R = r -i}$$

$$= \frac{D_0}{\theta - A + \lambda} [\frac{e^{(\lambda - R)t_1}}{\theta - A + R} \{e^{(\theta - A + R)t_1} - 1\} - \frac{1}{\lambda - R} \{e^{(\lambda - R)t_1} - 1\}] \tag{7}$$

The total number of deteriorated units during the inventory cycle is given by

$$D_T = \theta\int_0^{t_1} q(t)e^{-Rt}dt \text{, R = r – i}$$

$$= \frac{\theta D_0}{\theta - A + \lambda}\left[\frac{e^{(\lambda-R)t_1}}{\theta - A + R}\{e^{(\theta-A+R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - 1\}\right] \quad (8)$$

The total number of ameliorating units during the inventory cycle is given by

$$A_T = A\int_0^{t_1} q(t)e^{-Rt}dt \text{, R = r -i}$$

$$= \frac{AD_0}{\theta - A + \lambda}\left[\frac{e^{(\lambda-R)t_1}}{\theta - A + R}\{e^{(\theta-A+R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - 1\}\right] \quad (9)$$

The total number of shortages during the period [t_1, T] is given by

$$S_T = \int_{t_1}^{T} -q(t)e^{-Rt}dt \text{, R = r - i}$$

$$= \frac{D_0}{\lambda + \delta}e^{-\delta T}e^{(\lambda+\delta-R)t_1}\left[\frac{1}{R}\{e^{-R(T-t_1)} - 1\} + \frac{1}{\lambda + \delta - R}\{e^{(\lambda+\delta-R)(T-t_1)} - 1\}\right] \quad (10)$$

The amount of lost sales during the period [t_1,T] is given by

$$L_T = \int_{t_1}^{T} D(t)\{1 - e^{-\delta(T-t)}\}e^{-Rt}dt = \int_{t_1}^{T} D_0e^{\lambda t}\{1 - e^{-\delta(T-t)}\}e^{-Rt}dt \text{, R = r – i}$$

$$= \frac{D_0}{\lambda - R}e^{(\lambda-R)t_1}\{e^{(\lambda-R)(T-t_1)} - 1\} - \frac{D_0}{\lambda + \delta - R}e^{-\delta T}e^{(\lambda+\delta-R)t_1}\{e^{(\lambda+\delta-R)(T-t_1)} - 1\} \quad (11)$$

Inventory Scenarios

The following two distinct cases are considered due to the total depletion of the on-hand inventory at time $t_1(< T)$,

- $t_c \le t_1 < T$ (payment at or before the total depletion of inventory)
- $t_1 < t_c$ (payment after depletion of inventory)

The total interest payable over the entire cycle (0,T) is

$$IP = \begin{cases} IP_1, 0 < t_c \le t_1 \\ IP_2, t_1 < t_c < T \end{cases}$$

The total interest earned over the entire cycle (0,T) is

$$IE = \{ \begin{matrix} IE_1, 0 < t_c \le t_1 \\ IE_2, t_1 < t_c < T \end{matrix}$$

The total average cost of the system per unit time is given by

$$TC = \{ \begin{matrix} TC_1, 0 < t_c \le t_1 \\ TC_2, t_1 < t_c < T \end{matrix}$$

Case I: $t_c \le t_1 < T$ (Credit period is less or equal to depletion time of inventory):

Cost Components

The total inventory cost during the period [0, T] contains the following cost components:

- Ordering cost (OC) during the period [0,T]= A_0 (fixed)
- Purchasing cost (PC) during the period [0,T] **=** p_c I(0) = p_c Q

$$= p_c [\frac{D_0}{\theta - A + \lambda}\{e^{(\theta - A + \lambda)t_1} - 1\}]$$

Holding cost for carrying inventory (HC) during the period [0,T] = $h_c I_T$

$$= \frac{h_c D_0}{\theta - A + \lambda}[\frac{e^{(\lambda - R)t_1}}{\theta - A + R}\{e^{(\theta - A + R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda - R)t_1} - 1\}]$$

Cost due to deterioration (CD) during the period [0,T]= $d_c D_T$

$$= \frac{d_c \theta D_0}{\theta - A + \lambda}[\frac{e^{(\lambda - R)t_1}}{\theta - A + R}\{e^{(\theta - A + R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda - R)t_1} - 1\}]$$

The amelioration cost (AMC) during the period [0,T]= $a_c A_T$

$$= \frac{a_c A D_0}{\theta - A + \lambda}[\frac{e^{(\lambda - R)t_1}}{\theta - A + R}\{e^{(\theta - A + R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda - R)t_1} - 1\}]$$

Cost due to shortage (CS) during the period [0,T]= $c_s S_T$

$$= \frac{c_s D_0}{\lambda + \delta} e^{-\delta T} e^{(\lambda + \delta - R)t_1}[\frac{1}{R}\{e^{-R(T - t_1)} - 1\} + \frac{1}{\lambda + \delta - R}\{e^{(\lambda + \delta - R)(T - t_1)} - 1\}]$$

Opportunity Cost due to lost sales (OPC) during the period [0,T]= o_c L_T

$$= \frac{o_c D_0}{\lambda - R} e^{(\lambda - R)t_1}\{e^{(\lambda - R)(T - t_1)} - 1\} - \frac{D_0}{\lambda + \delta - R} e^{-\delta T} e^{(\lambda + \delta - R)t_1}\{e^{(\lambda + \delta - R)(T - t_1)} - 1\}$$

The total interest payable (IP_1) during the period [0,T]

$= p_c I_p \int_{t_c}^{t_1} q(t)e^{-Rt}dt$, R = r - i

$= \frac{p_c I_p D_0}{\theta - A + \lambda}[\frac{1}{\theta - A + R}\{e^{(\theta-A+\lambda)t_1}e^{-(\theta-A+R)t_c} - e^{(\lambda-R)t_1}\} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - e^{(\lambda-R)t_c}\}]$

The total interest earned (IE_1)during the period[0,T]

$= p_c I_e \int_0^{t_1} tD(t)e^{-Rt}dt$, R = r - i

$= \frac{p_c I_e D_0}{\lambda - R}[t_1 e^{(\lambda-R)t_1} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - 1\}]$

The total average inventory cost during the period [0, T] is given by the following

$TC_1(t_1) = \frac{1}{T}$[OC +PC+HC+CD+AMC+CS+OPC+ IP_1 - IE_1]

$= \frac{1}{T}[A_0 + \frac{p_c D_0}{\theta - A + \lambda}\{e^{(\theta-A+\lambda)t_1} - 1\} + \frac{(h_c + d_c\theta + a_c A)D_0}{\theta - A + \lambda}[\frac{e^{(\lambda-R)t_1}}{\theta - A + R}\{e^{(\theta-A+R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - 1\}]$

$+ \frac{c_s D_0}{\lambda + \delta}e^{-\delta T}e^{(\lambda+\delta-R)t_1}[\frac{1}{R}\{e^{-R(T-t_1)} - 1\} + \frac{1}{\lambda + \delta - R}\{e^{(\lambda+\delta-R)(T-t_1)} - 1\}]$

$+ \frac{o_c D_0}{\lambda - R}e^{(\lambda-R)t_1}\{e^{(\lambda-R)(T-t_1)} - 1\} - \frac{o_c D_0}{\lambda + \delta - R}e^{-\delta T}e^{(\lambda+\delta-R)t_1}\{e^{(\lambda+\delta-R)(T-t_1)} - 1\}$

$+ \frac{p_c I_p D_0}{\theta - A + \lambda}[\frac{1}{\theta - A + R}\{e^{(\theta-A+\lambda)t_1}e^{-(\theta-A+R)t_c} - e^{(\lambda-R)t_1}\} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - e^{(\lambda-R)t_c}\}]$

$- \frac{p_c I_e D_0}{\lambda - R}[t_1 e^{(\lambda-R)t_1} - \frac{1}{\lambda - R}\{e^{(\lambda-R)t_1} - 1\}]$](4.1)

The optimal (minimum) solution is obtained by solving $\frac{dTC_1(t_1)}{dt_1} = 0$

Or, $p_c e^{(\theta-A+R)t_1} + \frac{(h_c + d_c\theta + a_c A)}{\theta - A + R}\{e^{(\theta-A+R)t_1} - 1\} + \frac{c_s e^{-\delta(T-t_1)}}{R}\{e^{-R(T-t_1)} - 1\} + o_c\{e^{-\delta(T-t_1)} - 1\}$

$+ \frac{p_c I_p}{\theta - A + R}\{e^{(\theta-A+R)(t_1-t_c)} - 1\} - p_c I_e t_1 = 0$ (12)

For minimum, the sufficient condition $\frac{d^2TC_1(t_1)}{dt_1^2}$ >0 would be satisfied.

The optimal values Q^* of Q and TC_1^* of TC_1 are obtained by putting the optimal value $t_1 = t_1^*$ from the expressions (6) and (12)

Case II: $t_1 < t_c$ (Credit period is greater than the depletion time of inventory)

In this case, the retailer pays the procurement cost to the supplier prior to expiration of the trade credit period t_c provided by the buyer. Hence, there will be no the interest charged (IP_2 = 0) for the items kept in stock. Since the credit period is greater than the depletion time of inventory, the interest earned during the period [0, T] is given by the following

$$IE_2 = p_c I_e \int_0^{t_1} tD(t)e^{-Rt}dt + p_c I_e (t_c - t_1)\int_0^{t_1} D(t)e^{-Rt}dt \text{, R = r - i}$$

$$= \frac{p_c I_e D_0}{\lambda - R} [t_1 + (t_c - \frac{1}{\lambda - R})\{e^{(\lambda - R)t_1} - 1\}]$$

The total average inventory cost during the period [0,T] is given by the following

$$TC_2(t_1) = \frac{1}{T} [\text{OC +PC+HC+CD+AMC+CS+OPC+} IP_2 \text{ - } IE_2]$$

$$= = \frac{1}{T}[A_0 + \frac{p_c D_0}{\theta - A + \lambda}\{e^{(\theta - A + \lambda)t_1} - 1\} + \frac{(h_c + d_c\theta + a_c A)D_0}{\theta - A + \lambda}[\frac{e^{(\lambda - R)t_1}}{\theta - A + R}\{e^{(\theta - A + R)t_1} - 1\} - \frac{1}{\lambda - R}\{e^{(\lambda - R)t_1} - 1\}]$$

$$+ \frac{c_s D_0}{\lambda + \delta} e^{-\delta T} e^{(\lambda + \delta - R)t_1} [\frac{1}{R}\{e^{-R(T - t_1)} - 1\} + \frac{1}{\lambda + \delta - R}\{e^{(\lambda + \delta - R)(T - t_1)} - 1\}]$$

$$+ \frac{o_c D_0}{\lambda - R} e^{(\lambda - R)t_1}\{e^{(\lambda - R)(T - t_1)} - 1\} - \frac{o_c D_0}{\lambda + \delta - R} e^{-\delta T} e^{(\lambda + \delta - R)t_1}\{e^{(\lambda + \delta - R)(T - t_1)} - 1\}$$

$$- \frac{p_c I_e D_0}{\lambda - R} [t_1 + (t_c - \frac{1}{\lambda - R})\{e^{(\lambda - R)t_1} - 1\}]] \quad (13)$$

By the similar procedure as in case 1, the optimality equation $\frac{dTC_2(t_1)}{dt_1} = 0$ yields

$$p_c e^{(\theta - A + R)t_1} + \frac{(h_c + d_c\theta + a_c A)}{\theta - A + R}\{e^{(\theta - A + R)t_1} - 1\} + \frac{c_s e^{-\delta(T - t_1)}}{R}\{e^{-R(T - t_1)} - 1\} + o_c\{e^{-\delta(T - t_1)} - 1\}$$

$$- p_c I_e\{t_c + \frac{1}{\lambda - R}(e^{-(\lambda - R)t_1} - 1)\} = 0 \quad (14)$$

The above equation can be solved to find the optimal values of t_1, and then the optimal values of Q and TC_2 can be obtained from the expressions (6) and (13) respectively.

Numerical Example 1

Case I: $t_c \leq t_1 < T$ (Credit period is less or equal to depletion time of inventory):

Let the values of system parameters:

A_0 = \$500 per order, D_0 =200, $\lambda = 0.1$, θ_o = 0.02,A = 0.01, δ = 10, p_c = \$5 per unit, d_c = \$9 per unit, a_c = \$6 per unit, c_s = \$10 per unit, o_c = \$12 per unit, i = 0.08, r = 2, I_p = \$0.15 per unit, I_e = \$0.13 per unit, t_c = 0.2 year,T = 1 year

Solving the equation (4.2) with the help of computer using the above parameter values, we find the following optimum outputs

t_1^* = 0.355 year; Q^* = 72.40 units and TC^* = \$ 1006.32.

It is checked that this solution satisfies the sufficient condition for optimality.

Numerical Example 2

Case II: $t_1 < t_c$ (Credit period is greater than the depletion time of inventory)

Let the values of system parameters:

A_0 = \$500 per order, D_0 =200, $\lambda = 0.1$, θ_o = 0.02,A = 0.01, δ = 10, p_c = \$5 per unit, d_c = \$9 per unit, a_c = \$6 per unit, c_s = \$10 per unit, o_c = \$12 per unit, i = 0.08, r = 2, I_p = \$0.15 per unit, I_e = \$0.13 per unit, t_c = 0.5 year,T = 1 year

Solving the equation (4.4) with the help of computer using the above parameter values, we find the following optimum outputs

t_1^* = 0.352 year; Q^* =71.71 units and TC^* = \$1333.38.

It is checked that this solution satisfies the sufficient condition for optimality.

Effects of Inflation and Trade Credit Period on Optimal Solution

Table 1: (Credit Period is less or Equal to Depletion Time of Inventory)

Changing Parameters	Change in the System Parameters	Optimal Values		
		t_1^*	Q^*	TC_1^*
r	1 1.6 2.4 3	.578 .417 .303 .251	119.29 85.38 61.61 50.96	1130.30 1066.64 984.76 930.37
i	0.04 0.064 0.096 0.12	.349 .353 .357 .361	71.25 71.94 72.88 73.60	1002.64 1005.17 1008.42 1010.08

t_c	.1 .15 .3 .35	.351 .353 .358 .360	71.58 72.01 73.09 73.38	961.10 995.53 1081.37 1105.06

Table 2: (Credit Period is Greater Than the Depletion Time of Inventory)

Changing Parameters	Change in the System Parameters	Optimal Values		
		t_1^*	Q^*	TC_2^*
r	1 1.6 2.4 3	*** .418 .304 .252	- 85.47 61.74 51.07	- 1461.03 1256.06 1114.36
i	0.04 0.064 0.096 0.12	.346 .349 .354 .357	70.57 71.25 72.17 72.88	1322.17 1328.87 1337.93 1344.84
t_c	.4 .45 .55 .6	.350 .351 .353 .354	71.45 71.58 71.83 71.96	1329.61 1331.50 1334.26 1337.14

(*** indicates the infeasible solution)

Concluding Remarks

The present paper has been discussed for deteriorating and ameliorating items under the influence of inflation, time-value of money and permissible trade credit policy during a fixed planning horizon. The demand pattern is exponentially increasing with partially backlogged shortages. Again we could extend the model by analysing the effects of inflation and trade credit policy for both the cases i.e. case I and case II.

On the basis of the numerical data presented in the Table A, the following observation are made

- When the discount rate parameter(r) increases, the optimal values of on-hand inventory (Q) and average inventory cost (TC_1) decrease. It is also seen that these optimal values are more sensitively changing due to changes in the values of the parameter r.
- The optimal values of on-hand inventory (Q) and average inventory cost (TC_1) increase as the inflation rate parameter (i) increases. Here, the effects on these optimal values are negligible due to the changes in the values of the parameter i.
- When the permissible credit period (t_c) increases, the optimal values of on-hand inventory (Q) and average inventory cost (TC_1) increase. Moreover, the effect of the parameter t_c on the on-hand inventory (Q) is very low,

and that on the average inventory cost (TC_1) is very high.

On the basis of the numerical data presented in the Table B, the following observation are made

- The optimal values of on-hand inventory (Q) and average inventory cost (TC_2) decrease as the discount rate parameter(r) increases. These optimal values are moderately sensitive due to changes in the values of the parameter r.
- As the inflation rate parameter (i) increases, the optimal values of on-hand inventory (Q) and average inventory cost (TC_2) increase. We observe here that the effects on these optimal values are negligible due to the changes in the values of the parameter i.
- The optimal values of on-hand inventory (Q) and average inventory cost (TC_2) increase as the permissible credit period (t_c) increases. Moreover, the effects of the parameter t_c on the on-hand inventory (Q) and the average inventory cost (TC_2) are very low.
- Indicates the infeasible solution where the condition for Credit period being greater than the depletion time of inventory($t_1 < t_c$) is violated.

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