# Table of Content

**Chapter 1. Introduction** ........................................................................................................... 1
  1.1 Inventory Management ........................................................................................................ 2
  1.2 Effect of inflation on Inventory Management ................................................................. 3
  1.3 Different cost associated with inventory systems .............................................................. 4
    1.3.1 Ordering Cost .................................................................................................................. 4
    1.3.2 Holding Cost .................................................................................................................. 4
    1.3.3 Deteriorating Cost ......................................................................................................... 4
    1.3.4 Procurement/Manufacturing Costs ............................................................................... 5
    1.3.5 Shortage Cost ................................................................................................................ 5
  1.4 Inventory management Practice .......................................................................................... 5
  1.5 Inflation rate and Price ........................................................................................................ 7
  1.6 Inflation and Interest rate ................................................................................................... 7
  1.7 Permissible Delay in Payments .......................................................................................... 8
  1.8 Price – Dependent Demand Curve .................................................................................... 8
  1.9 Literature Review ................................................................................................................ 9
    1.9.1 Survey of Inventory Models with Inflation ................................................................. 10
    1.9.2 Survey of Inventory Models with Permissible Delay in Payments ............... 11
  1.10 Statement of the Present Problems: .............................................................................. 13
  1.11 Preview of Current work .................................................................................................. 14

**Chapter 2. Inventory Model for linearly price-dependent demand and with constant inflation rate** ................................................................................................................................. 18
  2.1 Introduction ....................................................................................................................... 19
  2.2 Model with constant permissible delay in payment ......................................................... 20
    2.2.1 Assumptions ................................................................................................................ 20
    2.2.2 Notations ..................................................................................................................... 21
    2.2.3 Mathematical Model ................................................................................................... 22
    2.2.4 Optimum Policy .......................................................................................................... 26
    2.2.5 Numerical Examples .................................................................................................. 29
    2.2.6 Sensitivity Analysis .................................................................................................... 30
    2.2.7 Discussion ................................................................................................................... 35
2.3  Model with order quantity dependent permissible delay in payments

2.3.1  Notations

2.3.2  Assumptions

2.3.3  Mathematical Model

2.3.4  Some Results

2.3.5  Algorithm

2.3.6  Numerical Example

2.3.7  Sensitivity Analysis

2.3.8  Discussion

2.4  Model with partial permissible delay in payment

2.4.1  Notations

2.4.2  Assumption

2.4.3  Mathematical Model

2.4.4  Some Results

2.4.5  Sensitivity Analysis

2.4.6  Discussion

Chapter 3.  Inventory Model for non-linear price-dependent demand and constant inflation rate

3.1  Introduction

3.2  An Ordering policy for iso-elastic demand under permissible delay in payments and price inflation

3.2.1  Notations and Assumptions

3.2.2  Mathematical Model

3.2.3  Some Results

3.2.4  Numerical Example

3.2.5  Sensitivity Analysis

3.2.6  Discussion

3.3  An Ordering policy for Hybrid demand under permissible delay in payments and price inflation

3.3.1  Notations

3.3.2  Assumptions

3.3.3  Mathematical Model
### 3.3.4 Profit Function
86

### 3.3.5 Results and Solution
89

### 3.3.6 Numerical Example
96

### 3.3.7 Sensitivity Analysis
97

### 3.3.8 Discussion
102

#### Chapter 4. An Inventory Model with price dependent demand under stochastic inflation rate
103

##### 4.1 Introduction
104

##### 4.2 An Inventory Model for price dependent demand and delay in payments under normally distributed Inflation rate
105

- **4.2.1 Notations**
105
- **4.2.2 Assumptions**
106
- **4.2.3 Mathematical Model**
106
- **4.2.4 Profit Function**
108
- **4.2.5 Algorithm and some Result**
112
- **4.2.6 Numerical Examples**
114
- **4.2.7 Sensitivity Analysis**
115
- **4.2.8 Discussion**
119

##### 4.3 An Inventory Model for Deteriorating Items with price Dependent Demand and Delay in Payments under Uncertain Inflationary Condition
120

- **4.3.1 Notations**
120
- **4.3.2 Assumptions**
121
- **4.3.3 Mathematical Model**
122
- **4.3.4 Profit Function**
124
- **4.3.5 Solution Procedure**
130
- **4.3.6 Numerical Example**
130
- **4.3.7 Sensitivity Analysis**
131
- **4.3.8 Discussion**
136

#### Chapter 5. An Inventory Model for deteriorating items with price dependent demand under stochastic inflation process
137

##### 5.1 Introduction
138
5.2 An Inventory Model for Deteriorating Items with Price Dependent Demand under Vasicek Model..........................138
  5.2.1 The Vasicek Model ..............................................................139
  5.2.2 Notations ...........................................................................141
  5.2.3 Assumptions .......................................................................141
  5.2.4 Mathematical Model.............................................................142
  5.2.5 Profit Functions .................................................................143
  5.2.6 Some Results.................................................................145
  5.2.7 Numerical Example .............................................................147
  5.2.8 Sensitivity Analysis ............................................................150
  5.2.9 Discussion ........................................................................153

5.3 An Inventory Model for Deteriorating Items with price Dependent Demand under CIR model ..........154
  5.3.1 Notations.........................................................................154
  5.3.2 Assumptions .......................................................................154
  5.3.3 The Cox-Ingersoll-Ross Model (CIR Model) ......................154
  5.3.4 Mathematical Model.............................................................155
  5.3.5 Profit Functions .................................................................160
  5.3.6 Algorithm .........................................................................163
  5.3.7 Numerical Example .............................................................163
  5.3.8 Sensitivity Analysis ............................................................165
  5.3.9 Discussion ........................................................................170

Chapter 6. Summary.................................................................171

6.1 Overview of the Thesis..........................................................172
  6.1.1 Summary of Chapter 1........................................................172
  6.1.2 Summary of Chapter 2........................................................172
  6.1.3 Summary of Chapter 3........................................................173
  6.1.4 Summary of Chapter 4........................................................173
  6.1.5 Summary of Chapter 5........................................................174

References ..................................................................................175
List of Tables

Table 2.2.1: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in profit with change in the length of the planning horizon and the permissible delay period in Example 2.2.1 ........................................................................................................30
Table 2.2.2: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in profit with change in inflation rate and deterioration rate in Example 2.2.1 ($H=1$) .........................................................................................................................31
Table 2.2.3: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in profit with selling price and interest earned in Example 2.2.1 ........32
Table 2.3.1: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in the length of the time horizon and the permissible delay period in Example 2.3.1 ........................................................................................................40
Table 2.3.2: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in profit with change in the inflation rate and the deterioration rate in Example 2.3.1 ........................................................................................................41
Table 2.3.3: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in profit with change in shortage cost and the fraction of the holding cost in Example 2.3.1 ........................................................................................................42
Table 2.3.4: Showing the change in the optimal values of $T_1$ and $T$ and percentage (absolute) change in profit with change in interest earned and interest payable in Example 2.3.1 ........................................................................................................43
Table 2.4.1: Showing change in optimum ($T_1$, $T$)-values and corresponding percentage (absolute) profit with change in $r$ for some combinations of ($T_{\alpha}$, $T_{1-\alpha}$) when $p = 25, s = 0.4, \alpha = 0.01, \alpha = 0.7$ ..................................................................................................................55
Table 2.4.2: Showing change in optimum ($T_1$, $T$)-values and corresponding percentage (absolute) profit with change in $I$ for some values of $T_{\alpha}$, $T_{1-\alpha}$ when $p = 25, s = 0.4, r = 0.06, \alpha = 0.7$ ..................................................................................................................56
Table 2.4.3: Showing change in optimum ($T_1$, $T$)-values and corresponding percentage (absolute) profit with change in $p$ for some values of $T_{\alpha}$, $T_{1-\alpha}$ when $s = 0.4, r = 0.06, \alpha = 0.7$ ..................................................................................................................58
Table 2.4.4: Showing change in optimum ($T_1$, $T$)-values and corresponding percentage (absolute) profit with change in $I_r$ for some combinations of ($T_{\alpha}$, $T_{1-\alpha}$) when $p = 25, s = 0.4, r = 0.06, \alpha = 0.7, I = 0.2, I_c = 0.14$ ..................................................................................................................59
Table 2.4.5: Showing change in optimum ($T_1$, $T$)-values and corresponding percentage (absolute) profit with change in $I_r$ for some combinations of ($T_{1-\alpha}$, $T_{\alpha}$) when $p = 25, s = 0.4, r = 0.06, \alpha = 0.7, I = 0.2, I_c = 0.12$ ..................................................................................................................60
Table 3.2.1: Optimal values of $t_p$, $T_1$ ($< M$) and $p_j$ for $n = 19$ ........................................................................79
Table 3.3.1: The optimal replenishment policy of example 3.3.1 ........................................................................96
Table 3.3.2: Change in the number of cycles, optimum profit and the percentage change in profit with change in the purchase cost price .........................................................................................97
Table 3.3.3: Change in the number of cycles, optimum profit and the percentage change in profit with change in the selling price .........................................................................................97
Table 3.3.4: Change in the number of cycles, optimum profit and the percentage change in profit with change in the delay period ..............................................................97
Table 3.3.5: Change in the number of cycles, optimum profit and the percentage change in profit with change in the planning horizon .........................................................98
Table 3.3.6: Change in the number of cycles, optimum profit and the percentage change in profit with change in the holding cost ...............................................................98
Table 3.3.7: Change in the number of cycles, optimum profit and the percentage change in profit with change in the lost sale cost ...............................................................98
Table 3.3.8: Change in the number of cycles, optimum profit and the percentage change in profit with change in the back ordered cost .......................................................99
Table 3.3.9: Change in the number of cycles, optimum profit and the percentage change in profit with change in the inflation rate .................................................................99
Table 3.3.10: Change in the number of cycles, optimum profit and the percentage change in profit with change in the net inflation rate and the intensity parameter ....................99
Table 3.3.11: Change in the number of cycles, optimum profit and the percentage change in profit with change in the intensity parameter ...................................................100
Table 3.3.12: Change in the number of cycles, optimum profit and the percentage change in profit with change in the deterioration rate ..............................................................100
Table 3.3.13: Change in the number of cycles, optimum profit and the percentage change in profit with change in the mixing parameter .........................................................100
Table 3.3.14: Change in the number of cycles, optimum profit and the percentage change in profit with change in the convex combination parameter ..................................101
Table 3.3.15: Change in the number of cycles, optimum profit and the percentage change in profit with change in the ordered cost ......................................................................101
Table 3.3.16: Change in the number of cycles, optimum profit and the percentage change in profit with change in the interest earned ..............................................................101
Table 3.3.17: Change in the number of cycles, optimum profit and the percentage change in profit with change in the interest charged ..............................................................102
Table 4.2.1: Changes in the values of the decision variables with change in I, and the corresponding % change in the expected profit from that when I = 0.05 .........................115
Table 4.2.2: Changes in the values of the decision variables with change in s, and the corresponding % change in the expected profit from that when s = 4 .............................116
Table 4.2.3: Changes in the values of the decision variables with change in /, and the corresponding % change in the expected profit from that when /= 0.12 ..................116
Table 4.2.4: Changes in the values of the decision variables with change in I, and the corresponding % change in the expected profit from that when /= 0.15 ..................117
Table 4.2.5: Changes in the values of the decision variables with change in p, and the corresponding % change in the expected profit from that when p = 230 ..................117
Table 4.2.6: Changes in the values of the decision variables with change in /, and the corresponding % change in the expected profit from that when /= 0.08 ..................118
Table 4.2.7: Changes in the values of the decision variables with change in the credit period M, and the corresponding % change in the expected profit from that when M = 0.1 ......................................................................................................................118
Table 4.2.8: Changes in the values of the decision variables with change in $\theta$, and the corresponding % change in the expected profit from that when $\theta = 0.1$.

Table 4.3.1: Changes in the values of the decision variables with change in $I$, and the corresponding % change in the expected profit from that when $I = 0.05$.

Table 4.3.2: Changes in the values of the decision variables with change in $M$, and the corresponding % change in the expected profit from that when $M = 0.1$.

Table 4.3.3: Changes in the values of the decision variables with change in $s$, and the corresponding % change in the expected profit from that when $s = 15$.

Table 4.3.4: Changes in the values of the decision variables with change in $\theta$, and the corresponding % change in the expected profit from that when $\theta = .02$.

Table 4.3.5: Changes in the values of the decision variables with change in $I_e$, and the corresponding % change in the expected profit from that when $I_e = 0.12$.

Table 4.3.6: Changes in the values of the decision variables with change in $I_r$, and the corresponding % change in the expected profit from that when $I_r = 0.15$.

Table 4.3.7: Changes in the values of the decision variables with change in $d$, and the corresponding % change in the expected profit from that when $d = 0.14$.

Table 4.3.8: Changes in the values of the decision variables with change in $w_1$, and the corresponding % change in the expected profit from that when $w_1 = 0.4$.

Table 4.3.9: Changes in the values of the decision variables with change in $w_2$, and the corresponding % change in the expected profit from that when $w_2 = 0.5$.

Table 4.3.10: Changes in the values of the decision variables with change in $b$, and the corresponding % change in the expected profit from that when $b = 0.1$.

Table 5.2.1: 3 years Inflation rate in India (starting from January 2012 source: MOSPI)

Table 5.2.2: Optimum replenishment policy.

Table 5.2.3: Changes in the values of the decision variables with change in $c$, and the corresponding % change in the expected profit from that when $c = 80$.

Table 5.2.4: Changes in the values of the decision variables with change in $p$, and the corresponding % change in the expected profit from that when $p = 100$.

Table 5.2.5: Changes in the values of the decision variables with change in $k$, and the corresponding % change in the expected profit from that when $k = 100$.

Table 5.2.6: Changes in the values of the decision variables with change in $A$, and the corresponding % change in the expected profit from that when $A = 50$.

Table 5.2.7: Changes in the values of the decision variables with change in $h$, and the corresponding % change in the expected profit from that when $h = 5$.

Table 5.2.8: Changes in the values of the decision variables with change in $s$, and the corresponding % change in the expected profit from that when $s = 3$.

Table 5.2.9: Changes in the values of the decision variables with change in $s_L$, and the corresponding % change in the expected profit from that when $s_L = 2$.

Table 5.2.10: Changes in the values of the decision variables with change in $r_0$, and the corresponding % change in the expected profit from that when $r_0 = 0.08$.

Table 5.2.11: Changes in the values of the decision variables with change in $\theta$, and the corresponding % change in the expected profit from that when $\theta = 0.08$. 
Table 5.2.12: Changes in the values of the decision variables with change in $\delta$, and the corresponding % change in the expected profit from that when $\delta$ = 3 ........................................153
Table 5.3.1: Optimum replenishment policy under CIR model ........................................165
Table 5.3.2: Changes in the values of the decision variables with change in $c$, and the corresponding % change in the expected profit from that when $c$ = 80 .................................166
Table 5.3.3: Changes in the values of the decision variables with change in $p$, and the corresponding % change in the expected profit from that when $p$ = 100 ..................................166
Table 5.3.4: Changes in the values of the decision variables with change in $a$, and the corresponding % change in the expected profit from that when $a$ = 500000 ..................167
Table 5.3.5: Changes in the values of the decision variables with change in $b$, and the corresponding % change in the expected profit from that when $b$ = 1.5 .........................167
Table 5.3.6: Changes in the values of the decision variables with change in $h$, and the corresponding % change in the expected profit from that when $h$ = 5 .........................167
Table 5.3.7: Changes in the values of the decision variables with change in $s$, and the corresponding % change in the expected profit from that when $s$ = 3 .........................168
Table 5.3.8: Changes in the values of the decision variables with change in $s_L$, and the corresponding % change in the expected profit from that when $s_L$ = 2 .........................168
Table 5.3.9: Changes in the values of the decision variables with change in $r_0$, and the corresponding % change in the expected profit from that when $r_0$ = 0.08 .........................168
Table 5.3.10: Changes in the values of the decision variables with change in $\theta$, and the corresponding % change in the expected profit from that when $\theta$ = 0.02 .........................169
Table 5.3.11: Changes in the values of the decision variables with change in $O$, and the corresponding % change in the expected profit from that when $O$ = 2500 ..........................169
Table 5.3.12: Changes in the values of the decision variables with change in $\delta$, and the corresponding % change in the expected profit from that when $\delta$ = 3 .........................169
List of Figures

Figure 2.2.1: Case I: Trade credit period is less than time when inventory becomes zero .................................................................................................................................24
Figure 2.2.2: Case II: Trade credit period is greater than time when inventory becomes zero ........................................................................................................................................25
Figure 2.3.1: Interest earned and Paid .....................................................................................................................................................................................37
Figure 2.3.2: Case of only Interest earned .....................................................................................................................................................................................37
Figure 2.4.1: Showing the the positions of $T_{\alpha}$ and $T_{1-\alpha}$ with respect to $T_1$ and $T$ in Case 1 ........................................................................................................................................................................47
Figure 2.4.2: Showing the the positions of $T_{\alpha}$ and $T_{1-\alpha}$ with respect to $T_1$ and $T$ in case 2 ........................................................................................................................................................................48
Figure 2.4.3: Showing the positions of $T_{\alpha}$ and $T_{1-\alpha}$ with respect to $T_1$ and $T$ in Case 3 ........................................................................................................................................................................49
Figure 3.2.1: Inventory level over the time horizon ..................................................................................................................................................................................67
Figure 3.2.2: Optimum Profit with respect to the inflation rate .........................................................................................................................................................81
Figure 3.2.3: Optimum Profit with respect to the deterioration rate .........................................................................................................................................................81
Figure 3.2.4: Optimum Profit with respect to the discount rate .........................................................................................................................................................81
Figure 3.2.5: Optimum Profit with respect to the interest earning rate .........................................................................................................................................................82
Figure 3.2.6: Optimum Profit with respect to the holding cost .........................................................................................................................................................82
Figure 3.2.7: Optimum Profit with respect to the price elasticity power(b) .........................................................................................................................................................83
Figure 3.2.8: Optimum Profit with respect to the permissible delay in payments .........................................................................................................................................................83
Figure 3.3.1: Inventory Level over time Horizon ..................................................................................................................................................................................85
Figure 4.2.1: The inventory policy over a finite planning horizon .........................................................................................................................................................107
Figure 4.3.1: The inventory policy over a finite planning horizon .........................................................................................................................................................122
Figure 5.3.1: Movement of CIR rate and actual inflation rate with respect to time .........................................................................................................................................................164