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T.C. Edwin Cheng · Jian Li · C.L. Johnny Wan ·  
Shouyang Wang

# Postponement Strategies in Supply Chain Management

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T.C. Edwin Cheng  
Department of Logistics & Maritime  
Studies  
The Hong Kong Polytechnic University  
11 Yuk Choi Road  
Hung Hom, Kowloon  
Hong Kong SAR  
lgtcheng@polyu.edu.hk

C.L. Johnny Wan  
Department of Logistics & Maritime Studies  
The Hong Kong Polytechnic University  
11 Yuk Choi Road  
Hung Hom, Kowloon  
Hong Kong SAR  
lgtwan@polyu.edu.hk

Jian Li  
School of Economics & Management  
Beijing University  
of Chemical Technology (BUCT)  
15 East Road of North Third Ring Road  
100029 Beijing  
China, People's Republic  
lijian@mail.buct.edu.cn

Shouyang Wang  
Chinese Academy of Sciences  
Academy of Mathematics & Systems  
Science  
55 Zhongguancun East Road  
100190 Beijing  
China, People's Republic  
sywang@amss.ac.cn

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# Abstract

Postponement is a supply chain strategy that enables a supply chain to achieve both low cost and fast response by combining some common processes and delaying other product differentiation processes such as packaging and labeling. The point that separates the differentiation processes from the common processes is known as the point of product differentiation. Recent research studies have identified four common postponement strategies, namely pull, logistics, form and price postponements. They aim at balancing the costs and benefits of mass production and customization. In this book, four types of model are presented to evaluate the impacts of pull and form postponement strategies under various supply chain structures.

First, we develop two EOQ-based models to examine the impact of pull postponement. Then we develop some EPQ-based models to examine the impact of postponement. The third type of model is a stochastic model of a single end-product supply chain that consists of a supplier, a manufacturer and a number of customers. In the last type of model, we aim at conducting a simulation experiment of a two-end-product supply chain, for which customer demands are discrete and independent. Besides mathematical models, two case studies from industry are presented to support our theoretical results.

**Keywords** Supply chain management, Postponement strategy



# Preface

Postponement strategy is one of the major supply chain management (SCM) practices that has a discernible impact on firms' competitive advantage and organizational performance. Postponement is a mass customization strategy that captures the advantages of both mass production and mass customization. Recent research studies have identified four common postponement strategies, namely *pull*, *logistics*, *form* and *price postponement*. The former three postponement strategies are linked to production and manufacturing, while the last one is a pure pricing strategy. They aim at balancing the costs and benefits of mass production and mass customization. Practical examples of postponement can be found in the high-tech industry, food industry and other industries that require high differentiation.

However, empirical studies have found that postponement may not be an evident SCM practice compared to the other practices. In addition, postponement has both positive and negative impacts on a supply chain. The advantages include following the JIT principles, reducing end-product inventory, making forecasting easier and pooling risk. The high cost of designing and manufacturing generic components is the main drawback of postponement. Thus, the evaluation of postponement strategy is an important research issue and there have been many qualitative and quantitative models for analyzing postponement under different scenarios.

The core of this book is to analyze how the pull postponement strategy and the form postponement strategy can be leveraged to yield substantial benefits to adopting firms in different competitive environments. This book is made up of seven chapters, the contents of which are outlined in the following.

In Chapter 1 we review the status of development of postponement. We begin with presenting a framework to link postponement with product variety, mass customization and quality. We then identify four types of postponement, followed by providing a review of the cost models for analyzing various postponement strategies. Finally, we present review of the literature pertinent to our model development.

In Chapter 2 we develop an EOQ-based model to examine the cost impact of the pull postponement strategy adopted by a supply chain that orders and keeps  $n$  end-products. We formulate a total average cost function for ordering and keeping the  $n$  end-products in a supply chain, in which their demands are known and deterministic. Using standard optimization techniques, we show that postponed customization of end-products will result in a lower total average cost and a lower EOQ. Furthermore,

we develop an EOQ-based model with perishable items to evaluate the impact of item deterioration rate on inventory replenishment policies. Our theoretical analysis and computational results show that a postponement strategy for perishable items can yield a lower total average cost under certain circumstances.

In Chapter 3 we develop two EPQ-based models with and without stockout to examine the impact of postponement. We formulate the total average cost functions of the two scenarios for producing and keeping  $n$  end-products in a supply chain, in which their demands are known and deterministic. Using standard optimization techniques, we show that postponed customization of end-products results in a lower total average cost in certain circumstances. We also find that two key factors that influence postponement decisions are variance of the machine utilization rates and variance of the backorder costs.

In Chapter 4 we study the cost impact of the pull postponement strategy by comparing the total average cost function with the optimal or an approximately optimal total average cost of an  $(r, q)$  policy. This is a stochastic model of a single end-product supply chain that consists of a supplier, a manufacturer and a number of customers. We develop two distinct models to represent the inventory system of the manufacturer. We employ Markov chain analysis to determine the exact average inventory level and the exact average accumulated backorder per period at the steady state so that the total average cost can be evaluated analytically. Also, we design an algorithm to find a near optimal total average cost per period. Our results show that the postponement system is more cost effective when the lead-time is zero, while the  $(r, q)$  inventory system is more effective when the lead-time is greater than zero.

In Chapter 5 we conduct simulation experiments of a two-end-product supply chain, for which customer demands are discrete and independent. Customer demands follow a uniform, Poisson or normal distribution. Two simulation models, namely one is a postponement system while the other is a non-postponement system, are designed for comparing their performance and total cost after  $t$  periods. Given a set of  $(r, q)$  policies and a demand distribution, the postponement system outperforms the non-postponement system in terms of average order frequency, average on-hand inventory, average backorder and average fill-rate. Thus, this system provides some cost benefits when the net postponement cost is low.

In Chapter 6 we report on two case studies of applying postponement strategy in industry. The first case is a study of a Hong Kong based toaster manufacturing company, which has successfully implemented postponement strategy. We present a summary of how postponement strategy was implemented in its supply chain and elaborate on all the benefits arising from the implementation of postponement. We also discuss the implications of postponement for its supply chain. In the second case study we present an empirical analysis of the application of postponement strategy in Taiwanese information technology (IT) firms. We present the findings and discuss their managerial and practical implications.

In Chapter 7 we conclude the book and suggest some worthy topics for future research.

This book is intended for researchers in supply chain management interested in conducting in-depth studies on postponement strategy. The book is also intended



for business practitioners seeking to understand the nature and law governing the working of postponement strategy and looking for guidance and decision support for the implementation of postponement strategy. Therefore, the book can be useful not only for researchers but also for practitioners and graduate students in operations management, management science, industrial engineering, and business administration.

We would like to thank many friends and colleagues for their help and support rendered to us in preparing this monograph. First, we thank Prof. Fangruo Chen of Columbia University, Prof. Xiuli Chao of the University of Michigan, Prof. Jeannette Song of Duke University, Prof. Gang Yu of the University of Texas at Austin, Prof. Hanqin Zhang, Prof. Ke Liu and Dr Jingan Li of the Academy of Mathematics and Systems Science of the Chinese Academy of Sciences for their helpful discussions, suggestions and valuable comments on our research in this area. We also thank many scholars who have made important contributions in this promising area, including Prof. Remko van Hoek of the Cranfield School of Management, Prof. Christopher S. Tang of the University of California at Los Angeles, Prof. Hau L. Lee of Stanford University, Prof. Jyh-Shen Chiou of National Chengchi University, Prof. Lei-Yu Wu of Van Nung Institute of Technology, and Prof. Jason C. Hsu of the University of California at Los Angeles, whose original research has inspired us to join this exciting field of research. Finally, we would like to thank the National Natural Science Foundation of China, the Research Grants Council of Hong Kong, the Chinese Universities Scientific Fund, the Natural Science Fund for Young Scholars of Beijing University of Chemical Technology, the Hong Kong Polytechnic University, the Academy of Mathematics and Systems Science of the Chinese Academy of Sciences, and Beijing University of Chemical Technology for their financial support to our research.

Hong Kong, China  
Beijing, China  
Hong Kong, China  
Beijing, China

T.C. Edwin Cheng  
Jian Li  
C.L. Johnny Wan  
Shouyang Wang



# Contents

<b>1</b>	<b>Introduction</b> .....	1
1.1	From Product Variety to Postponement .....	1
1.1.1	Product Variety .....	1
1.1.2	Mass Customization .....	2
1.1.3	Postponement Strategy .....	3
1.2	Classification of Postponement .....	3
1.2.1	Pull Postponement .....	4
1.2.2	Logistics Postponement .....	6
1.2.3	Form Postponement .....	7
1.2.4	Price Postponement .....	8
1.2.5	Implications .....	8
1.2.6	Advantages and Disadvantages of Postponement .....	9
1.2.7	Prerequisites for Postponement Strategy Development .....	10
1.3	Cost Models for Analyzing Postponement Strategies .....	11
1.3.1	Stochastic Models .....	11
1.3.2	Heuristic Models .....	12
1.3.3	Descriptive Models .....	13
1.3.4	Performance Measures .....	14
1.4	A Literature Review for Model Development .....	14
1.4.1	EOQ and EPQ Models .....	15
1.4.2	Lot Size-Reorder Point Model .....	16
1.4.3	Markov Chain .....	16
1.5	Concluding Remarks .....	17
<b>2</b>	<b>Analysis of Pull Postponement by EOQ-based Models</b> .....	19
2.1	Postponement Strategy for Ordinary (Imperishable) Items .....	19
2.1.1	Proposed Model and Assumptions .....	19
2.1.2	Case 1: Same Backorder Cost .....	22
2.1.3	Case 2: Different Backorder Costs .....	26
2.1.4	A Numerical Example .....	30
2.2	Postponement Strategy for Perishable Items .....	32
2.2.1	Notation and Assumptions .....	33
2.2.2	Model Formulation .....	34

- 2.2.3 The Postponement and Independent Systems ..... 38
- 2.2.4 Numerical Examples ..... 39
- 2.3 Concluding Remarks ..... 41
- 3 Analysis of Postponement Strategy by EPQ-based Models ..... 43**
  - 3.1 Analysis of Postponement Strategy by an EPQ-based Model without Stockout ..... 43
    - 3.1.1 Proposed Model and Assumptions ..... 43
    - 3.1.2 2 Machines for 2 End-Products ..... 46
    - 3.1.3  $n$  Machines for  $n$  End-Products ..... 56
  - 3.2 Analysis of Postponement Strategy by an EPQ-based Model with Planned Backorders ..... 62
    - 3.2.1 Proposed Model and Assumptions ..... 63
    - 3.2.2 Demands Are Met Continuously ..... 65
    - 3.2.3 Demands Are Met After Production Is Complete ..... 71
  - 3.3 Concluding Remarks ..... 78
- 4 Evaluation of a Postponement System with an  $(r, q)$  Policy ..... 81**
  - 4.1 The Proposed Models and Assumptions ..... 81
  - 4.2 System Dynamics for a Non-postponement System ..... 83
  - 4.3 The Algorithm for Finding a Near Optimal Total Average Cost of an  $(r, q)$  Policy ..... 84
    - 4.3.1 The Markov Chain Development ..... 84
    - 4.3.2 The Algorithm for Finding a Near Optimal Total Average Cost ..... 99
  - 4.4 System Dynamics for a Postponement System ..... 102
  - 4.5 Average Cost Comparison of the Two Systems When  $L = 0$  ..... 103
  - 4.6 Average Cost Comparison of the Two Systems When  $L \geq 1$  ..... 104
    - 4.6.1 An Overview of the Simulation Results ..... 104
    - 4.6.2 Impacts of Parameters on Average Cost ..... 106
  - 4.7 Concluding Remarks ..... 107
- 5 Simulation of a Two-End-Product Postponement System ..... 109**
  - 5.1 Proposed Model and Assumptions ..... 110
    - 5.1.1 Notation ..... 111
    - 5.1.2 Model Assumptions ..... 111
  - 5.2 Methodology ..... 112
    - 5.2.1 System Dynamics ..... 112
    - 5.2.2 The Simulation Model ..... 114
    - 5.2.3 Customer Demand Distribution ..... 114
    - 5.2.4 Order Quantity and Reorder Point ..... 115
    - 5.2.5 Summary of Parameters ..... 115
    - 5.2.6 Initial Conditions ..... 115
  - 5.3 Simulation Results for Non-cost Parameters ..... 117

- 5.3.1 Uniform Distribution ..... 117
- 5.3.2 Poisson Distribution ..... 118
- 5.3.3 Normal Distribution I ..... 119
- 5.3.4 Normal Distribution II ..... 120
- 5.4 Simulation Results for Cost Parameters ..... 121
- 5.5 Concluding Remarks ..... 123
  
- 6 Application of Postponement: Examples from Industry ..... 125**
  - 6.1 A Case Study from Hong Kong ..... 125
    - 6.1.1 An Overview of the Company ..... 126
    - 6.1.2 Implementation of Postponement ..... 126
    - 6.1.3 Benefits of Using Postponement ..... 127
    - 6.1.4 Implications ..... 128
  - 6.2 The Case of Taiwanese Information Technology Industry ..... 129
    - 6.2.1 The Hypothesis ..... 129
    - 6.2.2 Methodology ..... 130
    - 6.2.3 Results ..... 131
    - 6.2.4 Implications ..... 131
  - 6.3 Concluding Remarks ..... 132
  
- 7 Conclusions, Implications and Future Research Directions ..... 133**
  - 7.1 Conclusions ..... 133
  - 7.2 Implications and Further Research Directions ..... 134
  
- A Simulation Results (Uniform Distribution) ..... 137**
  
- B Simulation Results (Poisson Distribution) ..... 141**
  
- C Simulation Results (Normal Distribution I) ..... 147**
  
- D Simulation Results (Normal Distribution II) ..... 151**
  
- E Simulation Results for Cost Analysis ..... 155**
  
- References ..... 157**
  
- About the Authors ..... 163**
  
- Index ..... 165**



# List of Figures

- 1.1 A four-step supply chain process ..... 5
- 1.2 A revised four-step supply chain process ..... 6
- 2.1 A schematic diagram of the independent system ..... 20
- 2.2 A schematic diagram of the postponement system ..... 21
- 2.3 Demand over lead-time in a cycle for end-product  $i$  without  
postponement ..... 23
- 2.4 Demand over lead-time in a cycle for joint ordering  $n$  end-products  
with the same backorder cost ..... 24
- 2.5 Demand over lead-time in a cycle for joint ordering  $n$  end-products  
with different backorder costs ..... 28
- 2.6 Graphical representation of inventory level ..... 35
- 2.7 The impact of deterioration rate on cost ..... 40
- 2.8 The impact of deterioration rate on the difference in cost between  
the two systems ..... 40
- 3.1 A schematic diagram of the independent system ..... 44
- 3.2 A schematic diagram of the postponement system ..... 44
- 3.3 IP for end-product 1 and 2 in the independent system when  
the demand is met continuously ..... 47
- 3.4 IP for end-product 1 and 2 in the postponement system when  
the demand is met continuously ..... 49
- 3.5 IP for end-product 1 and 2 in the independent system when  
the demand is met after production is finished ..... 52
- 3.6 IP for end-product 1 and 2 in the postponement system when  
the demand is met after production is finished ..... 53
- 3.7 IP for product  $i$  in the non-postponement system when the demand  
is met continuously ..... 66
- 3.8 IP for  $n$  products in the postponement system when the demand is met  
continuously ..... 67
- 3.9 IP for product  $i$  in the non-postponement system when the demand  
is met after production is finished ..... 72
- 3.10 IP for  $n$  products in the postponement system when the demand is met  
after production is finished ..... 73
- 4.1 A schematic diagram of the postponement system ..... 82

- 4.2 A schematic diagram of the non-postponement system ..... 82
- 4.3 A plot of probability distribution diagram ..... 96
- 5.1 Process flow of the non-postponement system ..... 110
- 5.2 Process flow of the postponement system ..... 110
- 5.3 Flow chart for the non-postponement system ..... 113
- 5.4 Flow chart for the postponement system ..... 114
- 6.1 A process flow chart of the toaster company ..... 127
- A.1 Difference in average inventory (Uniform Distribution) ..... 139
- A.2 Difference in average backorder (Uniform Distribution) ..... 140
- A.3 Improvement in average fill rate (Uniform Distribution) ..... 140
- B.1 Difference in average inventory (Poisson Distribution) ..... 144
- B.2 Difference in average backorder (Poisson Distribution) ..... 145
- B.3 Improvement in average fill rate (Poisson Distribution)..... 146
- C.1 Difference in average inventory (Normal Distribution I) ..... 149
- C.2 Difference in average backorder (Normal Distribution I) ..... 150
- C.3 Improvement in average fill rate (Normal Distribution I) ..... 150
- D.1 Difference in average inventory (Normal Distribution II) ..... 153
- D.2 Difference in average backorder (Normal Distribution II) ..... 154
- D.3 Improvement in average fill rate (Normal Distribution II) ..... 154



# List of Tables

- 2.1 Parameters of 5 end-products ..... 31
- 2.2 The impact of deterioration rate on inventory replenishment policies ... 39
- 2.3 The impact of deterioration rate on the difference in cost ..... 40
- 3.1 A summary of the eight hypotheses without stockout ..... 45
- 3.2 A summary of the four hypotheses with stockout ..... 63
- 3.3 Impact of backorder costs when the demands are met continuously ... 76
- 3.4 Impact of machine utilization rates when demands  
are met continuously ..... 77
- 3.5 Impact of backorder costs when the demands are met after production  
is finished ..... 77
- 3.6 Impact of machine utilization rates when the demands are met after  
production is finished ..... 77
- 3.7 A summary of the findings of the eight hypotheses without stockout ... 78
- 3.8 A summary of the findings of the four hypotheses with stockout ..... 79
- 4.1 Number of states required ..... 86
- 4.2 The 13 data sets and their required states ..... 94
- 4.3 The probability distributions (in terms of  $N$ ) of the 13 data sets ..... 95
- 4.4 The probability distributions (in terms of  $R$ ) of the 13 data sets ..... 96
- 4.5 Iterative procedure for  $L = 1, a = 10$  ..... 103
- 4.6 A summary of the simulation results ..... 105
- 5.1  $(r, q)$  policy in different distributions ..... 116
- 5.2 Customer demand sets (Uniform Distribution) ..... 117
- 5.3 Lot size-reorder points  $(r, q)$  for the non-postponement system  
and the postponement system (Uniform Distribution) ..... 117
- 5.4 Customer demand sets (Poisson Distribution) ..... 118
- 5.5 Lot size-reorder points  $(r, q)$  for the non-postponement system  
and the postponement system (Poisson Distribution) ..... 118
- 5.6 Customer demand sets (Normal Distribution I) ..... 119
- 5.7 Lot size-reorder points  $(r, q)$  for the non-postponement system  
and the postponement system (Normal Distribution I) ..... 119
- 5.8 Customer demand sets (Normal Distribution II) ..... 120
- 6.1 Lead-time breakdowns for toaster offering ..... 126
- 6.2 Change in inventory before and after postponement implementation .... 128

6.3 The background statistics of the sample ..... 131

7.1 Summary of book findings ..... 135

A.1 Simulation results 1 (Uniform Distribution) ..... 137

A.2 Simulation results 2 (Uniform Distribution) ..... 138

B.1 Simulation results 1 (Poisson Distribution) ..... 141

B.2 Simulation results 2 (Poisson Distribution) ..... 142

C.1 Simulation results 1 (Normal Distribution I) ..... 147

C.2 Simulation results 2 (Normal Distribution I) ..... 148

D.1 Simulation results 1 (Normal Distribution II) ..... 151

D.2 Simulation results 2 (Normal Distribution II) ..... 152

E.1 Simulation results for cost analysis ..... 156