跬步集

2006上海大学－悉尼科技大学学术研讨会论文集

KUIBUJI

2006 SHANGHAI DAXUE-XINI KEJI DAXUE XUESHU YANTAOHUI LUNWENJI

主　编　龚思怡

副主编　胡笑寒　顾海悦

上海大学出版社

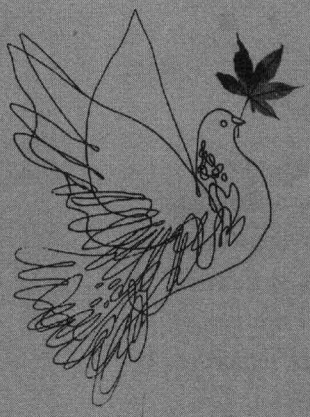
跬步集

2006上海大学－悉尼科技大学学术研讨会论文集

KUIBUJI

2006 SHANGHAI DAXUE-XINI KEJI DAXUE XUESHU YANTAOHUI LUNWENJI

主　编　龚思怡
副主编　胡笑寒　顾海悦



上海大学悉尼工商学院学术出版基金资助

上海大学出版社

图书在版编目(CIP)数据

跬步集：2006上海大学-悉尼科技大学学术研讨会论文集/龚思怡主编. —上海：上海大学出版社，2008.4
ISBN 978-7-81118-232-3

Ⅰ.跬… Ⅱ.龚… Ⅲ.社会科学-国际学术会议-文集
Ⅳ.C53

中国版本图书馆CIP数据核字(2008)第051570号

责任编辑 王悦生 封面设计 孙 敏 技术编辑 金 鑫

跬 步 集

——2006上海大学-悉尼科技大学学术研讨会论文集

主 编 龚思怡

副主编 胡笑寒 顾海悦

上海大学出版社出版发行

（上海市上大路99号 邮政编码200444）

（http://www.shangdapress.com 发行热线66135110）

出版人：姚铁军

*

上海华业装潢印刷厂印刷 各地新华书店经销

开本787×1092 1/16 印张20 字数559千字

2008年4月第1版 2008年4月第1次印刷

印数：1～1600

ISBN 978-7-81118-232-3/G·457 定价：50.00元

前 言

2006 上海大学-悉尼科技大学学术研讨会于 7 月 11 日在上海大学悉尼工商学院召开，随后出版的《跬步集——2006 上海大学-悉尼科技大学学术研讨会论文集》则是研讨会学术成果的充分证明。论文集的出版将促进两校间的学术交流和研究合作，它的出现可谓是两校学术合作进程中的里程碑。

近年来，随着中澳合作领域的扩大，两国教育机构之间的交流与合作也步入了一个新的阶段，上海大学悉尼工商学院正是此紧密合作的最佳佐证。上世纪 90 年代初期，在中外合作办学萌芽之际，上海大学和悉尼科技大学就合作创办了悉尼工商学院。作为沪上，甚至国内最早的中外合作院校，悉尼工商学院在过去的十多年间稳步发展，在研究生、本科和高职等多个层次提供高质量的双学位、双证书教育，大批优秀的毕业生服务于上海市经济社会发展的各个领域，每年更有一定数量的学生前往悉尼科技大学及其他世界各国的一流高等学府继续求学。两所学校在教育教学方面的合作日益深入和完善，双方都有强烈的意愿进一步加强其学术联系和研究合作。

正是在此背景下，悉尼工商学院于 2004 年 5 月成立了上海大学澳大利亚研究中心，致力于澳大利亚国别研究和中澳比较研究。凭借高效的工作机制，利用悉尼工商学院的合作办学背景，中心力争成为为中澳学者服务的信息资源中心、国际合作研究平台以及在澳大利亚研究这一特色领域有专长的研究机构。这次中心成功举办 2006 学术研讨会，就是为了促进上海大学和悉尼科技大学间的学术合作。

2006 上海大学-悉尼科技大学学术研讨会在上海大学美丽而富有文化底蕴的嘉定校区举行，邀请了来自悉尼科技大学和上海大学的众多学者参与，在社会、经济、商务和国家比较研究等方面展开了全面的讨论。在研讨会上，上海大学外语学院的庄恩平教授、悉尼工商学院的吕康娟副教授和体育教学部的王国勇博士分别作主题发言，众多的代表在商务论坛和文化论坛上作交流发言，悉尼科技大学商学院的科研副院长 Ian Palmer 教授和国际研究院的院长 Stephanie Donald 教授也应邀参加了会议。

研讨会上深入、热烈的讨论进一步激发了与会者对研究主题的兴趣，活跃而轻松的气氛既有助于思想的交流，也促进了大家之间的友谊和理解。更重要的是，研讨会提供了一个互相了解的机会，使中澳的学术同行们能相知相识，从而寻求未来合作的契机。

研讨会上我们不仅聆听了两校学者们的真知灼见，也欣喜地看到悉尼工商学院年轻教师的青春风采和在科研工作方面的进步。他们的积极参与不仅保证了研讨会的成功举办，也预示着悉尼工商学院开展科学研究的美好前景。我们将定期召开此类研讨会，使之成为上海大学和悉尼科技大学，甚至中外学者的学术交流平台。如果它确能为学者们交流信息和寻求更多研究机会创造条件，那么，这才是最大的成功和最终的目的。

在第一届研讨会论文集即将刊印之际，悉尼工商学院正在积极准备今年 11 月的 2007 中澳自由贸易区和服务业发展国际论坛，我们有理由相信并期待悉尼工商学院举办一个更加成功的国际学术思想峰会。

龚思怡

2007 年 10 月

Preface

The 2006 Shanghai University-UTS (University of Technology, Sydney) Academic Seminar was held at SILC (Sydney Institute of Language and Commerce), Shanghai University on July 11th. And the forthcoming publication of the Kui Bu Ji-Selected Papers of the 2006 Shanghai University-UTS Academic Seminar is ample proof of its academic success. Its publication will also usher in more academic exchange and research collaborations. Hence, it is justified to view the appearance of this collection of papers as a milestone in the scholarly cooperation between the two universities.

In recent years, with the expansion of cooperation between China & Australia, exchange and collaboration between educational institutions of the two countries march into a new age. The founding of SILC, Shanghai University is an excellent example to showcase such a close cooperation. In the early 1990s, the infancy period of Chinese-foreign cooperation in running schools, Shanghai University and UTS founded SILC with joint efforts. As the first joint venture institute in Shanghai, or even in China, SILC has developed steadily over the past 10 more years, providing high quality dual-degree and dual-certificate education for postgraduates, undergraduates and vocational students. A multitude of outstanding graduates from SILC make contributions to Shanghai's economic and social development. Each year, a certain number of graduates choose to pursue further studies in UTS or other famous universities all over the world. As the teaching cooperation between the two universities are becoming more profound and perfect, both parties have the strong wish to further strengthen their academic connection and research collaboration.

It was under this circumstance that the Shanghai University Australian Research Center was formally opened by SILC in May 2004 as an academic organization devoted to Australian studies and China-Australia comparative studies. Based on an efficient working mechanism and the cooperative background of SILC, the Center strives to become an information resource center for Chinese and Australian scholars, a platform for international cooperation and a research institute specializing in Australian studies. The successful hosting of the 2006 Academic Seminar is just an attempt to further promote the academic cooperation between the two universities.

The 2006 Shanghai University-UTS Academic Seminar was held on the beautiful Jiading Campus of Shanghai University. Scholars from both universities attended the seminar and carried out extensive discussions on social, economic, business and country comparative studies. Prof. Zhuang Enping from School of Foreign Languages, Associate Prof. Lv Kangjuan from SILC and Doctor Wang Guoyong from Physical Education Department delivered theme speeches on a variety of topics. All the participants were then divided into business and culture workshops for more

speeches and discussions. Professor Ian Palmer (vice-dean of the Faculty of Business, UTS) and Professor Stephanie Donald (dean of International Studies Institute, UTS) were also invited to attend the seminar.

The in-depth and heated discussions conducted at the seminar further enhanced and stimulated the academic interests of participants on various research topics. The lively and relaxed atmosphere provided the participants with an enjoyable experience not only for the exchange of views but also for the promotion of friendship and mutual understanding. More importantly, it is a good chance for scholars to know what their counterparts are doing and therefore to find potential partners for future research collaborations.

The seminar witnessed academic contributions made not only by scholars from Shanghai University and UTS, but also by young lecturers of SILC. These young scholars' active participation in the seminar contributed, first, to the success of the event, and then, to the further advancement of academic research at SILC and Shanghai University. We hope that the seminar will be hosted regularly as a platform for academic communication not only for the two universities but also for more scholars around the world. It will be a great success if it can serve as an information access for scholars to exchange their information and to explore more research opportunities, which is also its ultimate end.

While this collection of papers is going to the press, active preparations are being made for the 2007 China-Australia Studies Conference: Development of Free Trade Area and Service Industry between China and Australia, which will be hosted by SLIC in November this year. We are looking forward to a conference which, we believe, will be even more stimulating and successful.

Gong Siyi
October 2007

Contents

III. Language and Literature

IV. Sports Education and Industry

I. Economics and Business Management

Comparison Research on Accounting in Insurance Companies between Australia and China

CHEN Ying
Sydney Institute of Language and Commerce, Shanghai University, P. R. China, 201800

Abstract: In 2006, Australian Insurance Corporation became one of the shareholders of China Pacific Property Insurance Limited Company. As accounting is the international language of business, it is accelerated the coordination and cooperation between the two countries. The article distinguished the differences of accounting in Insurance Company. In the institutional economics view, in China it is the very short term for developing commercial insurance company there are the differences in internal control and production of accounting information, recording and matching the revenues and expenses, the contents of financial statements.

Keywords: Australia & China, insurance accounting, comparison research

1. Introduction

At Feb. 7, 2006 Australia Insurance corporation group(IAG), which is the biggest enterprise of car insurance and family property insurance in Australia subscribed the exclusive understanding memorandum with China Pacific Property Insurance Limited Company (CPPIC). IAG will purchase 24.9 percent shareholder's equity of CPPIC. According the memorandum if it is permitted by China Insurance Regulatory Commission, IAG will add their shareholder's equity to 40 percent in CPPIC. Pursuant to China's WTO accession commitments, foreign-funded P&C insurance companies are permitted to be engaged in non-life insurance business. During these years, IAG want to enter Chinese insurance market, thus this is the good chance for IAG. IAG will explore their market in China.

As accounting is the international language of business, it is accelerated the coordination and cooperation between the two countries. The article distinguished the differences of accounting in Insurance Company.

2. Actuality in China and Australia

During the development of Australia economy, British deeply affected Australia. Australia is a developed country, market economy. After divorcing from Commonwealth of Nations, accounting framework is seem as American pattern. Australia accounting standard board has issued a few accounting standard in Insurance company, such as AASB No.4 Insurance contract, AASB 1023 General Insurance contract, AASB 1038 Life Insurance contracts. Public state accounting

standard board, belonging to Australia accounting research funding issued AAS23 Financial report of General Insurance transaction. These standards standardized the accounting methods on general insurance and reinsurance transactions.

In the institutional economics view, in China it is the very short term for developing commercial insurance company. According accounting law, insurance companies use Insurance company accounting system, edited by treasury department in 1998. This system can satisfy the needs of investor but it can't custody the payment capability of insurance company. Insurance company cannot report the real assets and liabilities to the information users.

3. Comparison between China and Australia

There are the differences in internal control and recording transactions, processing the information of assets and liabilities, the contents of financial statements.

3.1 Liability adequacy test

An insurer shall assess at each reporting date whether its recognized insurance liabilities are adequate, using current estimates of future cash flows under its insurance contracts. If that assessment shows that the carrying amount of its insurance liabilities (less related deferred acquisition costs and related intangible assets) is inadequate in the light of the estimated future cash flows, the entire deficiency shall be recognized in profit or loss. If an insurer applies a liability adequacy test that meets specified minimum requirements, this Standard imposes no further requirements. The minimum requirements are the following: (a) the test considers current estimates of all contractual cash flows, and of related cash flows such as claims handling costs, as well as cash flows resulting from embedded options and guarantees; and (b) if the test shows that the liability is inadequate, the entire deficiency is recognized in profit or loss. If an insurer's accounting policies do not require a liability adequacy test that meets the minimum requirements the insurer shall determine the carrying amount of the relevant insurance liabilities less the carrying amount of any related deferred acquisition costs; and any related intangible assets, such as those acquired in a business combination or portfolio transfer.

Liability adequacy test benefit the payment capabilities custody for insurer. Insurance company in China should use for reference.

3.2 Disclosure of financial statements

3.2.1 Income statement

In relation to the income statement, the financial report shall disclose the underwriting result for the reporting period, determined as the amount obtained by deducting the sum of claims expense, outwards reinsurance premium expense and underwriting expenses from the sum of direct and inwards reinsurance premium revenues and recoveries revenue; net claims incurred shall be disclosed, showing separately the amount relating to risks borne in the current reporting period; and the amount relating to a reassessment of risks borne in all previous reporting periods.

An explanation shall be provided where net claims incurred relating to a reassessment of risks borne in previous reporting periods are material. This Standard requires the underwriting result for

the reporting period to be disclosed. This disclosure gives an indication of an insurer's underwriting performance, including the extent to which underwriting activities rely on investment income for the payment of claims. Based on the total movement in net claims incurred, it may appear that there has not been a material reassessment of risks borne in previous periods, however, there may be material movements at a business segment level, that mitigate each other. For example, the insurer may have seen a material deterioration in its motor portfolio, which has been mitigated by material savings in the professional indemnity portfolio, such that when both portfolios are aggregated there appears to have been little change in the reporting period. In such circumstances, the insurer provides an explanation of the reassessments that took place in the net claims incurred for previous periods during the reporting period at the business segment level.

3.2.2 Balance sheet

The financial report shall disclose in relation to the outstanding claims liability the central estimate of the expected present value of future payments for claims incurred; and the component related to the risk margin; the percentage risk margin adopted in determining the outstanding claims liability; the probability of adequacy intended to be achieved through adoption of the risk margin; and the process used to determine the risk margin, including the way in which diversification of risks has been allowed for. An insurer shall disclose the process used to determine which assets back general insurance liabilities and which assets back financial liabilities arising under non-insurance contracts.

References

[1] www.aasb.com.au

[2] Wang Xiangyao, Deng Chuan. Research on AASB's Accounting Standards and Its Strategy for International Convergence. Shanghai: Lixin Accounting Publishing House, 2005

[3] Treasury department. Financial Enterprises Accounting System, 2001

[4] Steve Laurence. International Accounting. International Thomson Business Press, 1996

Modeling and Simulating for A Distribution System Based on Fuzzy Systems to Forecast Demand

GAO Junjun[1], WANG Yingjun[2], HU Lejiang[3]

1 Sydney Institute of Language and Commerce, Shanghai University, P. R. China, 201800

2 Sydney Institute of Language and Commerce, Shanghai University, P. R. China, 201800

3 Shanghai Baosteel International Economic & Trading Co., Ltd., China

Abstract: A logistics cost model based on demand forecasting is proposed for a two-echelon distribution system with a central warehouse and multiple retailers in this paper. The retailers and the central warehouse all use periodic control policy to review their inventory level. First, we attempt to develop a fuzzy system-forecasting model capable of learning the IF-THEN rules obtained from demand data and experience of marketing experts with respect to promotions. Then we build a comprehensive model to combine demand forecasts with inventory decision and distribution system cost model. Finally, fuzzy system-forecasting model is compared to conventional regression method by a numerical example and its results indicate that the proposed fuzzy system-forecasting model performs more accurately than the conventional regression method. The computational results also show that substantial cost savings and improved service level can be realized through applying fuzzy systems to forecast demand.

Keywords: demand forecasting, inventory decision, supply chain management

1. Introduction

In today's global marketplace, individual firms no longer compete as independent entities, but rather as integral parts of supply chain linkage. Therefore, supply chain management (SCM) has attracted increasing attention in academics and practitioners. In the field of supply chain management, the researches on modeling for distribution systems have become increasingly important topics of interest to many researchers[4]. While most models for distribution systems frequently assume that market demand follow some probability distribution with specified mean and deviation. Actually, retailers do not know the exact forms of demands and often apply various forecasting technologies to predict the real demand. So demand forecasting is obviously essential for the construction of a distribution system model and is the basis of all distribution system strategy and planning, especially when determining an effective inventory control policy. Thus, it is necessary and important to incorporate demand forecasts into distribution systems modeling.

Recently, there are some literatures on the impact of accuracy of the final demand forecasts on the performance of a supply chain, but the tools to predict demand are mostly conventional statistic methods[4-5], which hardly fit the complicated demand processes well enough and furthermore cannot take some factors influencing demand mode into consideration, such as promotion. Conventional quantitatively statistical methods are primarily time series methods and casual methods. Time series models have a fatalistic aspect in that they assume the past will repeat itself without being influenced by external factors. Thus, the company may be well advised to

combine statistical analysis with managerial judgment about short-, medium-, and long-term outlooks for company sales. Even causal methods including regression and econometric methods are susceptible to an over reliance on historical data, which again suggests the need to combine them with managerial judgment. Therefore, correctly combining quantitative analysis and qualitative analysis into a forecasting system is a critical challenge in the field of supply chain management. For fuzzy systems providing a general method for handling uncertain and irregular information in demand forecasting in many real-world decision-makings, it is a valuable tool to solve the above difficulties, even the demand data is insufficient. Although there exists some studies in the forecasting area attempting to improve forecasting accuracy through similar methods, such as artificial neural networks models, fuzzy neural networks models and statistical models embedded genetic algorithms etc., they did not take into account the impact of forecasting model on the performance of distribution systems so as not to provide sufficient guidelines for practicing managers to make inventory decisions based on demand forecasts[6-10].

Thus, this paper attempts to develop a fuzzy system-forecasting model capable of learning the IF-THEN rules obtained from demand data and experiences of marketing experts with respect to promotions. Then we build a comprehensive model to combine demand forecasts with inventory decision and distribution system cost model for a two-echelon distribution system with a central warehouse and multiple retailers. Next fuzzy system-forecasting model is compared to conventional regression method by a numerical example and its results indicate that the proposed fuzzy system-forecasting model performs more accurately than the conventional regression model. The results also show that substantial cost savings and improved service level can be realized through applying fuzzy systems to forecast demand. The findings can also help supply chain managers select suitable forecasting models to improve distribution systems performance. Finally, we present our conclusion and the open problems in future researches.

2. Assumptions and notations

Assumptions used in our model are as follows:

(1) The distribution system consists of a central warehouse and m retailers selling single-product to customers, shown in Figure 1.

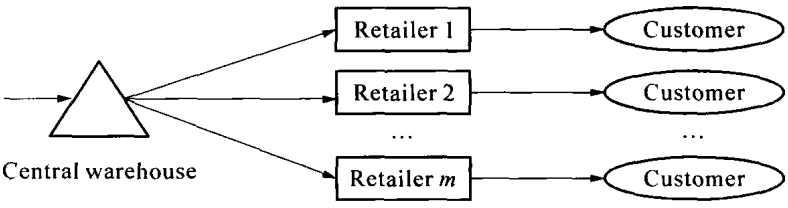


Figure 1 The structure of the distribution system

(2) Assume that the product is in its mature stage of the whole product-life period, such as beers with a well-known brand. Furthermore, the demand of this product has uncertainty and obvious seasonality. When being the period of promotion, its demand would get a short-term rise in demand. Product promotion takes a fashion of sending presents and its expenditure would be burdened by the manufacturer.

(3) All unfilled demand at retailers would result in lost sales.

(4) The central warehouse and all retailers use periodic interview policy to control their inventory level and their interview period are all T days. And the time of placing an order at all retailers is identical.

(5) For simplifying the computation, we assume that the lead time from central warehouse to retailers and from manufacture to central warehouse are both T days, which means that retailers and central warehouse would place their order at the end of each period and the replenishments would arrive at the end of next period.

(6) Stock-out in central warehouse is not allowed. Once shortage happened, central warehouse would emergency purchase product from other suppliers.

The subscript j represents jth retailer and the subscript t represents tth period. The subscript r and w denote retailers and central warehouse, respectively. Let O, H, T, S, E represents ordering cost, inventory holding cost, transportation cost, shortage cost and emergency procurement cost. Other notations are summarized as follows: D — demand (units); Q — order quantity (units); I — on-hand inventory level at the end of period (units); $\overline{I}$— average inventory level (units); SQ — shortage quantity (units); h — inventory holding cost per unit per year; O — fixed ordering cost; V — variable ordering cost; nT — the length of whole planning level; SL — service level.

3. Modeling for a distribution system

3.1 Retailers applying fuzzy systems to forecast demand

An important contribution of fuzzy systems theory is that it provides a systematic procedure for transforming a knowledge base into a nonlinear mapping. Fuzzy systems consists of fuzzier, which transforms a real-valued x into a fuzzy set in input space U, and fuzzy inference engine, which combines fuzzy IF-THEN rules into a mapping from fuzzy sets in the input space U to fuzzy sets in the output space V based on fuzzy logic principles, as well as defuzzier, which transforms a fuzzy set into a real-valued y in output space V, shown in Figure 2.

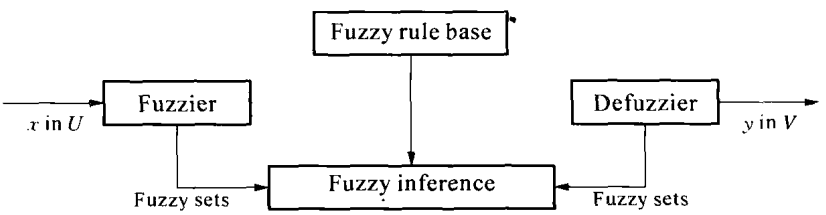


Figure 2 Basic configuration of fuzzy systems[11]

We will use the fuzzy systems designed by a simple heuristic table look-up scheme to predict demand faced by retailers and the designing procedures of table look-up scheme is as follows [11]:

Step 1: Define fuzzy sets to cover the input and output spaces;

Step 2: Generate one rule for one input-output pair;

Step 3: Assign a degree to each rule generated in step 2;

Step 4: Generate the fuzzy rule base; intuitively, we can illustrate a fuzzy rule base as a look up table in the two-input case;

Step 5: Construct the fuzzy system based on fuzzy rule base.

Specially, for retailer $j(j=1,2,\cdots,m)$ using periodic interview inventory control policy and lead-time from central warehouse to retailers is equal to retailers' review period, i. e. T days, retailer j would receive its order quantity of $t-2$ period at the end of $t-1$ period. Thus the order placed at $t-2$ period can be used to satisfy demand of tth period. Therefore, the retailers need to forecast demand of t period at the end of $t-2$ period. Here we choose real demand data happened at $t-2$ and $t-3$ period to forecast demand of tth period. Let $\{D_{j0}, D_{j1}, D_{j2}, \cdots, D_{jn}, \cdots\}$ denotes jth retailer's real demand amount and further this demand forecasting problem can be formulated as follows.

Given $D_{j(t-2)}$, $D_{j(t-3)}$, estimate D_{jt}. That is, the task is to determine a mapping from $[D_{j(t-2)}, D_{j(t-3)}] \in \mathbf{R}^3$ to $[D_{jt}] \in \mathbf{R}$, and we can form $n-3$ input-output pairs based on D_{j1}, D_{j2}, $\cdots$, D_{jn} as follows:

$$\begin{aligned} &[D_{j1}, D_{j2}, D_{j4}] \\ &[D_{j2}, D_{j3}, D_{j5}] \\ &\cdots \\ &[D_{j(n-3)}, D_{j(n-2)}, D_{jn}] \end{aligned} \tag{1}$$

And let $\{D'_{j0}, D'_{j1}, D'_{j2}, \cdots, D'_{jn}, \cdots\}$ denotes jth retailer's demand forecasting value. The computational method of table look-up scheme [11] would be illustrated in our numerical example in Section 4.

Retailer j estimates his on-hand inventory level at the end of tth period according to his on-hand inventory level of $(t-1)$th period based on its demand forecasting. Thus we get

$$I'_{jt} = [I_{j(t-1)} + Q_{j(t-1)} - D'_{jt}]^+ \tag{2}$$

where $[a]^+ = \max\{a, 0\}$.

3.2 Demand forecasting at central warehouse

Similarly, central warehouse estimates the demand of tth period at the end of $t-2$ period. So the real data used by central warehouse to forecast the demand of tth period is that happened at $t-2$ and $t-3$ period. According to assumptions, we know that demand faced by central warehouse actually is the sum of order quantity placed by all retailers. Then we get the demand estimating value D'_{wt} in tth period is:

$$D'_{wt} = A_0 + A_1 D_{w(t-2)} + A_2 D_{w(t-3)} \tag{3}$$

where A_0, A_1, A_2 is underestimated parameter.

Central warehouse estimates his on-hand inventory level at the end of tth period according to his on-hand inventory level of $(t-1)$th period based on its demand forecasting. Thus we get

$$I'_{wt} = [I_{w(t-1)} + Q_{w(t-1)} - D'_{wt}]^+ \tag{4}$$

3.3 The cost model for retailer j

The total cost of retailer j $(j=1, 2, \cdots, m)$ is the sum of inventory holding cost, shortage cost, ordering cost and transportation cost. Each part of total cost is calculated as follows.

(1) Computation of inventory holding cost

We have known that retailer j would receive his order quantity of tth ($t = 1, 2, \cdots, n$) period at the end of ($t+1$) period. Therefore, the order quantity of tth ($t = 1,2,\cdots,n$) period placed by retailer j would equal to demand forecasting value for ($t+2$) period plus stock-out quantity happened in tth period (SQ_{jt}) and minus on-hand inventory level estimating value of ($t+1$) period. That is

$$Q_{jt} = SQ_{jt} + D'_{j(t+2)} - I'_{j(t+1)} (j = 1, 2, \cdots, m;\ t = 1, 2, \cdots, n) \tag{5}$$

If $I'_{j(t+1)} > 0$, we institute formula (2) into (5), then we can get

$$Q_{jt} = \frac{1}{2}(SQ_{jt} + D'_{j(t+2)} + D'_{j(t+1)} - I_{jt}) \tag{6}$$

If $I'_{j(t+1)} = 0$, then

$$Q_{jt} = SQ_{jt} + D'_{j(t+2)} \tag{7}$$

Retailer j's on-hand inventory level I_{jt} at the end of t period is the on-hand inventory level at last-end-period plus the arrival amount for ordering at former period, then minus amount of this period's real demand, that is

$$I_{jt} = [I_{j(t-1)} + Q_{j(t-1)} - D_{jt}]^+ \tag{8}$$

where retailer j's on-hand inventory level at the end of 0th period is the sum of demand mean in each period and seasonal inventory as well as safety inventory, that is

$$I_{j0} = \mu_j + s_j + ss_j \tag{9}$$

$$ss_j = k_j \cdot n_j + MAD_j \tag{10}$$

where k_j is the safety factor, n_j is demand deviation factor, $MAD_j = \frac{1}{n}\sum_{t=1}^{n} | D'_{jt} - D_{jt} |$ is mean absolute deviation, which is the average of the absolute deviation over all periods.

Because retailer j's stock-out quantity at the end of 0 period is zero, we can get retailer's order quantity at 0 period from (6) is

$$Q_{j0} = \frac{1}{2}(D'_{j2} + D'_{j1} - I_{j0}) \tag{11}$$

Then we can get retailer j's average inventory level over n periods as follows.

$$\begin{aligned} I_j &= \frac{1}{n}\sum_{t=1}^{n}\left[\frac{I_{j(t-1)} + (I_{j(t-1)} - D_{jt})}{2}\right] \\ &= \frac{1}{n}\sum_{t=1}^{n}\left(I_{j(t-1)} - \frac{1}{2}D_{jt}\right) \end{aligned} \tag{12}$$

Finally, the expression for inventory holding cost C_{jH} at retailer j is given by

$$\begin{aligned} C_{jH} &= h_j \cdot I_j \\ &= h_j \cdot \frac{1}{n}\sum_{t=1}^{n}\left(I_{j(t-1)} - \frac{1}{2}D_{jt}\right) \end{aligned} \tag{13}$$

(2) Computation of lost sales

Retailer j's stock-out quantity at t period equal to real demand at t period minus on-hand inventory level and order quantity of last period, which is given by

$$SQ_{jt} = [D_{jt} - I_{j(t-1)} - Q_{j(t-1)}]^+ \tag{14}$$

Then the lost sales (C_{jS_t}) for retailer j equal to unit price (P) multiplying stock-out quantity at t period, that is

$$C_{jS_t} = P_j \cdot SQ_{jt} = P_j \cdot [D_{jt} - I_{j(t-1)} - Q_{j(t-1)}]^+ \tag{15}$$

(3) Computation of ordering cost and transportation cost

Retailer j's ordering cost C_{jO_t} at t period is given by

$$C_{jO_t} = O_j + V_j \cdot Q_{jt} \tag{16}$$

Retailer j's transportation cost C_{jT_t} at t period equal to unit transportation cost T_j multiplying the shipment quantity at t period, which is given by

$$C_{jT_t} = T_j \cdot Q_{jt} \tag{17}$$

(4) Computation of total cost

Therefore, we can get retailer j's total costs (TC_{rj}) over n periods,

$$TC_{rj} = \sum_{t=1}^{n} (C_{jO_t} + C_{jT_t} + C_{jS_t}) + C_{jH}$$
$$(j = 1, 2, \cdots, m;\ t = 1, 2, \cdots, n) \tag{18}$$

The service level (SL_j) at retailer j equal to the proportion that the demand is filled immediately over the whole planning level, that is

$$SL_j = 1 - \frac{\sum_{t=1}^{n} SQ_{jt}}{\sum_{t=1}^{n} D_{jt}} \quad (j = 1, 2, \cdots, m;\ t = 1, 2, \cdots, n) \tag{19}$$

3.4 The cost model for central warehouse

The total costs at central warehouse include ordering cost, transportation cost, inventory holding cost and emergency procurement cost. Each part of total cost is calculated as follows.

The demand faced by central warehouse at the end of t period is the sum of m retailers' order quantity. That is

$$D_{wt} = \sum_{j=1}^{m} Q_{jt} \quad (j = 1, 2, \cdots, m;\ t = 1, 2, \cdots, n) \tag{20}$$

The order quantity placed by central warehouse at the end of tth period equal to his forecasting value of demand at $(t+2)$th period minus the forecasting value of on-hand inventory level at the end of $(t+1)$th period. That is

$$Q_{wt} = D'_{w(t+2)} - I'_{w(t+1)}$$

If $I'_{w(t+1)} > 0$, instituting formula (4) into the above equation, we have

$$Q_{wt} = (D'_{w(t+2)} + D'_{w(t+1)} - I_{wt})/2 \tag{21}$$