行政院國家科學委員會專題研究計畫　成果報告

應用具符號距離方法於無缺貨模糊存貨模型之研究

計畫類別： 個別型計畫
計畫編號： NSC92-2416-H-034-004-
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計畫主持人： 李惠明

計畫參與人員： 施登山　　毛敬豪

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行政院國家科學委員會補助專題研究計畫成果報告

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※　　應用具符號距離方法於無缺貨模糊存貨模型之研究　　※

※　**Using Signed Distance Method for Fuzzy Inventory without Backorder**　※

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□國際合作研究計畫國外研究報告書一份

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一、 中文摘要

在無缺貨存貨模型總成本函數 $F(q)=\dfrac{c\cdot T\cdot q}{2}+\dfrac{a\cdot r}{q}$ 中，其中 (q>0)， a 為每段定貨費、c 為每單位量單位時間之存庫費、T 為計畫期間、 r 為計畫期間中之總需求量、q 為每段定貨量，$F(q)$是假定在計畫期間 T 中各段訂貨點至到貨點期間、每段需求量均固定而導出者。

但是在實際問題中各段訂貨點至到貨點期間不一定均相等而會有少許變動，我們曾於 1999 年[Lee and Yao: Fuzzy Sets and Systems, Vol. 105, No. 1 (1999) 13-31] 提出「Economic Order Quantity in Fuzzy Sense for Inventory without Backorder Model」將 q 模糊化為三角模糊數 $\tilde{q}=(q_1,q_0,q_2)$ 求得模糊總成本、並用重心法解得最佳定貨量；於 1999 年[Yao and Lee: Fuzzy Sets and Systems, Vol. 105, No. 3 (1999) 331-337] 提出「Fuzzy Inventory with or without Backorder for Fuzzy Order Quantity with Trapezoid Fuzzy Number」將 q 模糊化為梯形模糊數 $\tilde{q}=(q_1,q_2,q_3,q_4)$ 求得模糊總成本、並用重心法解得最佳定貨量。

由於不僅 q 會有些許變動， r、 c 與 a 亦可能會有些許變動，因此我們於本研究中將 q、 r、 c、 a 同時模糊化為三角模糊數 $\tilde{q}=(q_1,q_0,q_2)$、$\tilde{r}=(r_1,r_0,r_2)$、$\tilde{c}=(c_1,c_0,c_2)$、$\tilde{a}=(a_1,a_0,a_2)$，由 $F(q)$我們可得模糊總成本函數 $G(\tilde{q},\tilde{r},\tilde{a},\tilde{c})=((\dfrac{\tilde{T}}{2})\otimes\tilde{c}\otimes\tilde{q})\oplus(\tilde{a}\otimes\tilde{r}\ominus\tilde{q})$。

為求以模糊觀點之總成本估計值，我們可以應用擴張原理求得 $G(\tilde{q},\tilde{r},\tilde{a},\tilde{c})$ 的隸屬函數、再應用重心法解模糊化以求得最佳定貨量，然應用此法不但極為繁雜而且極難求得解。

本研究係應用具符號距離法（Signed Distance Method）取代擴張原理與重心法以求得模糊觀點之總成本估計值、並解得最佳定貨量。由於我們應用此方法導出的過程較之前利用擴張原理求得最適解更為簡捷、效果亦頗佳，因此，本研究深具重要性。

關鍵詞：模糊存貨模型；模糊總成本；具符號距離法

Abstract

In the classical inventory without backorder model, the cost function is $F(q)=\dfrac{c\cdot T\cdot q}{2}+\dfrac{a\cdot r}{q}$, ($q$>0), where c is the stock cost per unit quantity per time, a is the order cost per cycle, T is the plan for the whole period, r is the total demand quantity of T, and q is the order quantity per cycle. The crisp economic order quantity is solved under the condition that both the demand for each cycle and the period from ordering to delivery are fixed. But, they probably will have some little disturbances for each cycle in the real situation. In 1999, we fuzzified the order quantity per cycle q as the triangular fuzzy number and obtained the fuzzy total cost [Lee and Yao, Fuzzy Sets and Systems, Vol. 105, No. 1 (1999) 13-31]. Also, in 1999, we fuzzified the order quantity per cycle q as the trapezoid fuzzy number and obtained the fuzzy total cost

[Yao and Lee, Fuzzy Sets and Systems, Vol. 105, No. 3 (1999) 331-337]. We applied the extension principle to find the membership functions of the fuzzy total cost, then, we applied the centroid method to estimate the total cost in fuzzy sense and obtained the optimization problems. In this study, we fuzzify the *q*, *r*, *c* and *a* as the triangular fuzzy numbers $\tilde{q}=(q_1,q_0,q_2)$, $\tilde{r}=(r_1,r_0,r_2)$, $\tilde{c}=(c_1,c_0,c_2)$, $\tilde{a}=(a_1,a_0,a_2)$, respectively, then we can obtain the fuzzy total cost $G(\tilde{q},\tilde{r},\tilde{a},\tilde{c})=((\frac{\tilde{T}}{2})\otimes\tilde{c}\otimes\tilde{q})\oplus(\tilde{a}\otimes\tilde{r}\oslash\tilde{q})$, where $(\frac{\tilde{T}}{2})=(\frac{T}{2},\frac{T}{2},\frac{T}{2})$ is the fuzzy point.

In order to find the total cost in the fuzzy sense, we may apply the extension principle to solve the membership function of the fuzzy total cost $G(\tilde{q},\tilde{r},\tilde{a},\tilde{c})$, and then, defuzzify by the centroid method to estimate the total cost in the fuzzy sense and obtain the optimization problems. But, it is very hard and complex to derive them.

In this study, we apply the signed distance method instead of the extension principle and centroid method to solve the estimated total cost in the fuzzy sense to obtain the optimal order quantity. The proposed method in this study will not only be derived easily but also have the good results. Therefore, the proposed method in this study is important in the fuzzy sense of the inventory without backorder model.

Keywords: Fuzzy inventory model; Fuzzy total cost; Signed distance

二、計畫緣由與目的

緣由

存貨問題中無論是無缺貨存貨模型或是有缺貨存貨模型均係作業研究學門中甚為重要的研究課題，從以前到最近均有甚多的學者投入於此領域的研究行列，亦均有很好的成果。

然而，當與環境稍許變動情況下有關的變數時，亦即當處於模糊環境下有關的變數時，如何求得最佳訂貨量是極為重要的課題。有鑑於此，我們曾於 1998 年【*Lee and Yao, European Journal of Operational Research, Vol. 109, No. 1 (1998), 203-211*】提出「Economic Production Quantity for Fuzzy Demand Quantity and Fuzzy Production Quantity」、於 1998 年【*Chang, Yao and Lee, European Journal of Operational Research, Vol. 109, No. 1 (1998), 183-202*】提出「Economic Reorder Point for Fuzzy Backorder Quantity」、於 1999 年【*Lee* and Yao, *Fuzzy Sets and Systems, Vol. 105, No. 3 (1999), 13-31*】提出「Economic Order Quantity in Fuzzy Sense for Inventory without Backorder Model」、於 1999 年【*Yao and Lee, Fuzzy Sets and Systems, Vol. 105, No. 3 (1999), 331-337*】提出「Fuzzy Inventory with or without Backorder for Fuzzy Order Quantity with Trapezoid Fuzzy Number」，以模糊理論處理與環境稍許變動情況下有關的變數，以求得最適解。

由於上述四篇期刊論文均利用擴張原理求得最適解，其導出過程是極為繁雜的；在本研究中我們提出應用具符號距離法於無缺貨模糊存貨模型以求得模糊觀點之總成本估計值、並解得最適解。

由於我們應用此方法導出的過程較之前利用擴張原理求得最適解更為簡捷、效果亦將較佳，因此，本研究深具重要性。

目的

在無缺貨存貨模型總成本函數 $F(q)=\frac{c\cdot T\cdot q}{2}+\frac{a\cdot r}{q}$ 中，其中 (q>0)，a 為每段定貨費、c 為每單位量單位時間之存庫費、T 為計畫期間、r 為計畫期間中之總需求量、q 為每段定貨量，*F(q)*是假定在計畫期間 T 中各段訂貨點至到貨點期間、每段需求量均固定導出者。

但是在實際問題中各段訂貨點至到貨點期間不一定均相等而會有少許變動，因此我們曾於 1999 年【*Lee and Yao*: Fuzzy Sets and Systems, Vol. 105, No. 1 (1999) 13-31】提出「Economic Order Quantity in Fuzzy Sense for Inventory without Backorder Model」將 *q* 模糊化為三角模糊

數 $\tilde{q}=(q_1, q_0, q_2)$ 求得模糊總成本、並用重心法解得最佳定貨量;又於 1999 年【*Yao and Lee*: Fuzzy Sets and Systems, Vol. 105, No. 3 (1999) 331-337】提出「Fuzzy Inventory with or without Backorder for Fuzzy Order Quantity with Trapezoid Fuzzy Number」將 q 模糊化為梯形模糊數 $\tilde{q}=(q_1, q_2, q_3, q_4)$ 求得模糊總成本、並用重心法解得最佳定貨量。

由於不僅 q 會有些許變動，r、c 與 a 亦可能會有些許變動，因此我們於本研究中將 q、r、c、a 同時模糊化為三角模糊數 $\tilde{q}=(q_1, q_0, q_2)$ 、 $\tilde{r}=(r_1, r_0, r_2)$ 、 $\tilde{c}=(c_1, c_0, c_2)$ 、$\tilde{a}=(a_1, a_0, a_2)$ ，由 $F(q)$ 我們可得模糊總成本函數 $G(\tilde{q}, \tilde{r}, \tilde{a}, \tilde{c})=((\frac{\tilde{T}}{2})\otimes\tilde{c}\otimes\tilde{q})\oplus(\tilde{a}\otimes\tilde{r}\ominus\tilde{q})$ 。

為求以模糊觀點之總成本估計值，我們可以應用擴張原理求得 $G(\tilde{q}, \tilde{r}, \tilde{a}, \tilde{c})$ 的隸屬函數、再應用重心法解模糊化以求得最佳定貨量，然應用此法不但極為繁雜而且極難求得解。

本研究係應用具符號距離法（Signed Distance Method）取代擴張原理（Extension principle）與重心法（Centroid）以求得模糊觀點之總成本估計值、並解得最佳定貨量。

本研究的目的係應用具符號距離法以求得模糊觀點之總成本估計值、並解得最佳定貨量，由於式子的導出將較為容易、而且計算較為簡單。尤其當式子中的分母被模糊化後，如應用擴原理欲求得最適解將是難上加難；然而，我們於本研究中所應用的方法極為簡捷、成效亦頗佳。

三、結果與討論

本計畫中我們應用具符號距離法以求得模糊觀點之總成本估計值、並解得最佳定貨量，由於式子的導出將較為容易、而且計算較為簡單。從表一至表五中我們可以得知本計畫所提的方法與我們之前【*Lee and Yao*: Fuzzy Sets and Systems, Vol. 105, No. 1 (1999) 13-31】所提的方法計算結果誤差極小，但是計算簡便。

四、 研究成果自評

本計畫之研究成果目前已有一篇論文『A Fuzzy Inventory Model without Backorder』於國際學術會議『Tenth ISSAT international Conference on Reliability and Quality in Design』上發表，pp. 295-298, August 5-7, 2004, Las Vegas, Nevada, USA；另有一篇論文已投稿至國際學術期刊『International Journal of Uncertainty, Fuzziness and Knowledge-based Systems』，目前正在審稿中。

本計畫之研究內容與原計畫相符程度為 100%，也 100%達成預期目標

五、 參考文獻

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Table 1 Comparison the result of this study with [6] for Case 1

This paper								Paper in [6]			
Δ_1	Δ_2	Δ_3	Δ_4	Δ_5	Δ_6	q^{**}	FC	q_0^{**}	M	q_r^{**}	FCr
0.1	0.2	0.3	0.1	0.2	0.3	6.319	48.0715	6.12314	48.18231	2.8709	-0.230
02.	0.2	0.2	0.2	0.2	0.2	6.276	48.2765	6.14214	48.2765	2.179	0.195

Table 2 Comparison the result of this study with [6] for Case 2

This paper								Paper in [6]			
Δ_1	Δ_2	Δ_3	Δ_4	Δ_5	Δ_6	q^{**}	FC	q_0^{**}	M	q_r^{**}	FCr
0.1	0.2	0.3	0.1	0.2	0.3	5.625	48.5198	5.66667	48.27129	0.735	0.515
02.	0.2	0.2	0.2	0.2	0.2	5.625	48.6788	5.66667	48.27129	0.735	0.844

Table 3 Comparison the result of this study with [6] for Case 3

This paper								Paper in [6]			
Δ_1	Δ_2	Δ_3	Δ_4	Δ_5	Δ_6	q^{**}	FC	q_0^{**}	M	q_r^{**}	FCr
0.1	0.2	0.3	0.1	0.2	0.3	6.55	48.4110	6.56667	48.23762	0.254	0.359
02.	0.2	0.2	0.2	0.2	0.2	6.55	48.2570	6.56667	48.23762	0.254	0.040

Table 4 Optimal solution for Δ_j =0, j=1, 2, …, 6

Case	q_1^*	q^*	q_2^*	q^{**}	FC	q_r^*(%)	F_r(%)
1	5.30861	6.28267	7.01297	6.2217	48.18095	3.696	0.377
2	4.5	5.5	7.0	5.625	48.52407	-6.25	1.092
3	6.2	6.5	7.0	6.55	48.21224	9.167	0.442

Table 5 Comparison the result of this study for Δ_j =0, j=1, 2, …, 6 with [6]

This paper (for Δ_j =0, j=1, 2, …, 6)			Paper in [6]			
Case	q^{**}	FC	q_0^{**}	M	q_r^{**}	FC_r(%)
1	6.22173	48.18095	6.14214	48.18231	1.2958	-0.00282
2	5.625	48.52407	5.66667	48.27129	-0.73535	0.52366
3	6.55	48.21224	6.56667	48.23762	-0.25385	-0.05261