2014

ISSN : 0974 - 7435 Volume 10 Issue 12

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(12), 2014 [6019-6025]

Dynamic pricing strategy for seasonal products under different demand intensity

Gu Ming-chong[1], Liu Hong[2], Yan Ji[3]*

[1,2]College of Business Administration, University of Science and technology, Liaoning, (CHINA)

[3]Institute of Applied Technology, University of Science and technology, Liaoning, (CHINA)

E-mail: mingchong121@163.com, nyliuhong@163.com, nyliuhong@163.com

ABSTRACT

Due to the sales time is shorter of seasonal products, how to sell the product to consumers at the best price in the sales period becomes the key determinants of retailers' income level. This paper set the seasonal products as the research object; maximize the retailers' profit as the goal, using the revenue management thought to research the corresponding dynamic pricing problems of seasonal products in different intensities of demand. The purpose is to discuss the different demand intensity and inventory levels under the impact on the retailer's optimal pricing. By setting a certain type of poison type dynamic pricing model, obtained in determining the type of demand under the condition of the retailer's optimal pricing and optimal benefits, with the result of numerical example to analyze the existing features, summed up the optimal pricing consumer demand is increasing function of the model; Product sales period is the product of the optimal pricing of decreasing function; Under the certain demand intensity, the optimal pricing with the increase of inventory was first increasing then decreasing trend.

KEYWORDS

Seasonal products; Dynamic pricing; Demand intensity; Non decreasing function.

INTRODUCTION

Seasonal products refers to sales in certain seasons or within a certain period of the product, the sales cycle is short, generally speaking, sales of seasonal products for a period of five to seven weeks, the price will drop, constantly with the decrease of sales period, residual value at the end of the season is zero, so the seasonal goods belongs to the fast consumer goods. With vegetables and fashion products, for example, the price of vegetables is not only affected by the changes of supply and demand in the market , but also affected by the vegetable freshness, In the invariant premise of market supply and demand level, fresh vegetable prices will be relatively high, with fewer sales period, its freshness is on the decline, prices fell, the sales at the end of the residual to zero; Fashion product life cycle is also consistent with this rule, in the product has just launched, the hearts of consumers will be reserved for higher prices, are willing to pay higher prices, but with the end of the sales period, as a fashion product value does not exist, so its residual value can be considered to be zero.

To maximize the benefits of revenue management is the supply and demand for products to adjust the price of the market, and ultimately achieve the price and supply and demand balance, and with the most superior price to sell the products to consumers, so the dynamic product pricing is particularly important. Traditional pricing method of seasonal products, such as cost plus pricing and competition oriented pricing method does not ensure that the maximization of benefits, such as in the case of demand intensity change, enterprises can quickly formulate corresponding strategies, revenue management and dynamic pricing method is to some extent for the perfection of its shortcomings. Based on revenue management thoughts as the instruction, this paper discussed under different intensity of demand, the optimal profit and the rule of the optimal price, for retailers in a timely manner to provide reference for corresponding pricing strategies.

RESEARCH STATUS AT HOME AND ABROAD

Dynamic pricing is refers to the enterprise according to the market demand and supply capacity of its own, with the different price will be the same kind of products timely sales to different customers and different segments of the market, has been the realization of profit maximization strategy[1]. Dynamic pricing as a method of revenue management is very important, is the research on revenue management theory domestic and foreign scholars study the most, theory of revenue management in the 1970 s in the process of the rise and development, domestic and foreign scholars in this research also has obtained many achievements, made a strong theoretical support for follow-up studies.

Yang Hui and Zhou Jing (2006,2007) studied the problem of setting price point, they by setting about price point Stacklberg game model and Cournot game model to explore in what point reduction for the influence of corporate earnings. Stacklberg game equilibrium results show that the first move of cut date will be postponed, and access to more than the monopoly situation of the proceeds, on the other hand, the enterprise will gets ahead of time, the income will reduce accordingly; Cancelled in the Cournot game 1 the price of product in the former assumption, the equilibrium result is the same as the equilibrium result of Stacklberg game model[2, 3].

Guan Zhen-zhong and Shi Ben-shan (2007) studied the situation of a substitute product facing out of stock in coping strategies, considering the situation of consumer strategic behavior is studied under the seller's order quantity and the optimal pricing strategy[4].

Wang Hong-da, Hao Yige (2007) studied the seasonal product promotion model and its algorithm, through the analysis of the profit of discount goods corresponding model is established, and the model derivation and solution, through the example analysis of the genetic algorithm is higher than the correct rate of the particle swarm algorithm[5].

Huang He (2007) studied the short life cycle products supply chain coordination of dynamic pricing problem, analyzed three kinds of different contract mode in supply chain: buy back contract, price discount contract and revenue sharing contract, the conclusion is in the 3 kinds of typical contract, only the supply chain profit sharing contract can achieve under dynamic pricing policy coordination[6].

Liu Xiao-feng (2008) studies the influence of the design contract dynamic pricing mechanism of strategic consumers and returned to retailers and consumers, the research results are as high prices higher proportion of customers market when the price return strategy can improve the total retail revenues, while high prices customers' low ratio can not be implemented refund policy[7].

Liu Xiao-feng, Huang Pei (2009) studied the optimal pricing and the corresponding inventory strategy, the research results show that the manufacturer's optimal mechanism is to select the appropriate inventory and the corresponding prices make higher retention value of consumers in the first stage at a higher price to buy, to avoid the loss of part of potential suppliers profit[8].

LiuJian, Luo Chunlin (2009) based on fuzzy decision and variational method was carried out on a video of the dynamic pricing research, vendors to determine the price function and consumption patterns of consumer strategy choice, formed between a game and the corresponding dynamic game model is established and the game is balanced, using the variational method for online purchase of dynamic pricing problem[9].

Li Gen-dao, Xiong Zhong-kai, Nie Jia (2009) Studied on the demand of perishable products dynamic pricing problem of inventory and price, to obey the homogeneous Poisson process in the customer, the demand rate is not only affected by price is also affected by the residual amount of inventory, proved that the given inventory optimal value function is a concave function of time, increase the optimal pricing strategy with time without reducing. Under different parameters are found considering stock dependent demand under the strategy will increase the income for the enterprise, increase in some cases the ratio is relatively large[10].

Bitran (1998) extended the pricing model of a single retailer to more than one chain retail stores, and the product price is the same in the chain, but different locations of shops facing their poisson process requirements[11].

Zhao and Zheng (2000) expanded the GVR model, studies the demand of the dynamic pricing problem in the process of non homogeneous Poisson, prove that the optimal price decreases with an increase in the number of inventory at any given point nature remains, but the optimal pricing strategy monotonicity is no longer formed over time[12].

Bitran (2005) studied the dynamic pricing problem of multiple alternative products. The author considers the joint product of two kinds of alternative relations in retailing: prices drive alternative, i.e., the change of the price vector will affect the way customers buy products; Inventory-driven alternative, that is, when a product is out of stock part of the product demand will turn to other similar products[13].
Zhang and Cooper (2008) for dynamic pricing constructs a markov decision process, the numerical experiment show that problems based on the summary of the strategies for symmetry effect is very good, but the result is bad in case of asymmetric[14].

Aviv and Pazgal (2008) studied in random arrival of consumers, retailers, how to carry out the dynamic pricing problem,in this paper the consumer value as a time for the deterministic function, the consumer according to dynamic pricing vendors at different stages of their own surplus, it is according to decide how much to the rest of the purchase of goods at what stage[15].

Lai (2009) study of dynamic pricing to focus on different kinds of consumers of different pricing strategies, exist in the market strategy under the condition of consumers and short-sighted consumers, two cycles of a dynamic game model is established, through the model the game result of old finally decided to the manufacturer's optimal pricing strategy and the optimal inventory levels, at the same time discusses the under price return mechanism set up affect benefits consumers and retailers[16].

ESTABLISH THE MODEL

Assume that the seasonal product life cycle is a time period [0, T], The assumption that the consumer strength demand for products is λ (P) of the Poisson process, where λ (P) is demand determined rules, inventory of initial n. In a time of T, the retailer set a price P, retailers to sell this product probability for λ (P) t, probability of unsold for 1- λ (P) t, defines a set of discrete pricing set,

from the price, select the optimal price, the retailer can be, flexible to adjust the price according to product sales.

Define the optimal pricing strategy set

$$\cup = \{ p_1(t), p_2(t), p_3(t), \ldots \}, \qquad 0 \le t \le T \tag{1}$$

St

$$\int_0^T d N_i(t) \le n \tag{2}$$

$$\lambda t \in \Lambda = \{ \lambda(p) : p_k(t) \in P \} \tag{3}$$

The sales period for the expected revenue

$$J_u(n,t) = E\left(\int_0^T p_i(t)\, d N_i(t) \right) \tag{4}$$

For any u ∈ U, and (1) the maximum value, can obtain the maximum expected profit

$$J^*(n,t) = \sup_{u \in U} J_u(n,t) \tag{5}$$

And the J (n, t) meet two conditions

$$J(0,t) = 0 \qquad \forall\ t \tag{6}$$

$$J(n,0) = 0 \qquad \forall\ n \tag{7}$$

The optimal revenue can be expressed as

$$J^*(n,t) = \sup_{\lambda} \left[\lambda t (p(\lambda) + J^*(n-1, T-t) + (1-\lambda t) J^*(n, T-t) \right] \tag{8}$$

According to the viscosity control point process theory, the optimal expected function (5) shall meet the following a Hamilton Jacobi optimal equation:

$$\begin{aligned} \frac{\partial J^*(t,n)}{\partial t} &= \sup_{\lambda} \{ r(\lambda) - \lambda [J^*(n,t) - J^*(n-1,t)] \} \\ &= \sup(\lambda \{ p - [J^*(n,t) - J^*(n-1,t)] \}) \end{aligned} \tag{9}$$

Since the optimal solution of equation 6 is not easy to find, so take the special circumstances, $\lambda(p) = ae^{-p}$, take the function into exponential function to solve, here we use (Gallego et al., 1994) research[17], the optimal revenue and optimal price respectively

$$J^*(n,t) = \ln \sum_{i=1}^{n} \frac{(\lambda t)^i}{i!} \tag{10}$$

$$p^*(n,t) = J^*(n,t) - J^*(n-1,t) + 1 \quad \textbf{(11)}$$

According to the results of Gallego et al., the optimal revenue is strictly increasing function for N, the optimal price with n strictly decreasing, with t strictly increasing. In order to make the analysis more intuitive and easy to understand, the author adopts the following example to the analysis.

EXAMPLE

TABLE 1 gives the strength in demand under different, calculated with the Excel table type (10) and (11) the specific arithmetical optimal benefit and the optimal price.

TABLE 1 : Optimal expected revenue and optimal pricing

n	Λ`t=10		λt=20		λt=30	
	J*(n,t)	p*(n,t)	J*(n,t)	p*(n,t)	J*(n,t)	p*(n,t)
1	2.302585	3.302585	2.995732	3.995732	3.401197	4.401197
2	6.214608	4.912023	8.294050	6.298317	9.510445	7.109248
3	11.330604	6.115996	15.489487	8.195437	17.922278	9.411833
4	17.362890	7.032287	24.294362	9.804875	28.349013	11.426736
5	24.088324	7.725434	34.485532	11.191170	40.567509	13.218495
6	31.324584	8.236259	45.880674	12.395142	54.395442	14.827933
7	38.917518	8.592934	58.325639	13.444965	69.678662	16.283220
8	46.733596	8.816078	71.686894	14.361255	86.283638	17.604976
9	54.655034	8.921438	85.846657	15.159763	104.092587	18.808949
10	62.576472	8.921438	100.699567	15.852910	123.000148	19.907561
11	70.402601	8.826128	116.150314	16.450747	142.911012	20.910863
12	78.046407	8.643807	132.111887	16.961573	163.738166	21.827154
13	85.427850	8.381442	148.504243	17.392356	185.401568	22.663402
14	92.472820	8.044970	165.253274	17.749031	207.827110	23.425542
15	99.112325	7.639505	182.289986	18.036713	230.945799	24.118689
16	105.281826	7.169501	199.549843	18.259856	254.693097	24.747298
17	110.920699	6.638873	216.972218	18.422375	279.008379	25.315282
18	115.971786	6.051086	234.499954	18.527736	303.834487	25.826108
19	120.381018	5.409233	252.078983	18.579029	329.117353	26.282866
20	121.794519	2.413500	269.658012	18.579029	354.805684	26.688331

Through the observation of the data, the inventory level is certain, with the increasing strength of demand, the optimal pricing retailers monotonously increasing trend, which shows that the retailer's optimal pricing is demand intensity increasing function; And in the strength of demand in certain circumstances, the retailer's optimal pricing increases along with the increase of inventory, reaches a maximum in the inventory will reach the strength of demand and demand strength is equal to the latter, but once the inventory amount is greater than the strength of demand, the optimal price retailers to showing a decreasing trend, indicating greater than demand intensity in the inventory of the case, the optimal pricing retailers there exists a critical point, the critical point is the point of demand intensity. According to revenue management theory, the price of the product is adjust the level of supply and

demand of products, until the balance of supply and demand, the inventory and demand intensity is equal to the balance of retailer of the optimal inventory level.

The analysis and summary for the following conclusions:

(1) Under a certain inventory level, the optimal pricing is increasing function of the strength of consumer demand, the consumer demand intensity at some point, the greater the optimal pricing is higher, the demand intensity is smaller, the smaller the optimal pricing, so retailers can according to the customer to change strength determines the price level, so as to obtain higher income..

(2) How much inventory will have a significant impact on dynamic pricing, when $\lambda t>n$, namely demand strength consumers than inventory of products, with the increase of N, the optimal price strictly increasing, the optimal revenue is strictly increasing, in the $\lambda t=n$, optimal prices reached the highest, when $\lambda t<n$, the optimal price and strict decrease with the increase of N, the optimal revenue increase first and then decrease, so the need to make the retailer's optimal inventory $n^* = \lambda t$.

(3) Due to the demand of consumer sales period strength is strictly non decreasing function, so the strength of demand derived sales period influence on the optimal price. With the same seasonal products in different regions there are two different sales cycle of A1 and A2, the corresponding prices are respectively P1 and P2, if A1>A2, then P1>P2 vendors should be made in the pricing strategy, if A1<A2, then the optimal pricing P1<P2.

CONCLUSION

This paper deals with the determination of dynamic pricing problem of seasonal product Poisson stochastic demand, through the design of a sales time is T, the inventory for the N pricing model, to find out the optimal pricing and the most profitable model, setting the corresponding numerical through demand intensity on the model of the numerical optimal pricing and income in different intensities, obtained the following conclusions from numerical observations, (1) the optimal pricing is strictly increasing function of strength of consumer demand; (2) the inventory level has significant effects on the optimal pricing of products in the strength of demand, the optimal inventory levels, income increase with the present increase in the trend of decline, the strength of demand and inventory levels are equal, the optimal pricing retailers to reach the maximum, so the optimal stock offer retailers is equal to the strength of demand; (3) the sale period and the product price is positively related to the optimal sales period, long product take the price setting in pricing can be, while the sales period is short products, pricing can not adopt high price strategy.

REFERENCE

[1] Zhou Jing, Yang Hui; Revenue management method and application, Beijing, Science Press, **(2009)**.

[2] Yang Hui, Zhou Jing; The perishable products price point set a Cournot game model of. Chinese management science, **3**, 45-50 **(2006)**.

[3] Yang Hui Zhou Jing; Perishable goods on time of the stackelberg game, Journal of Management Engineering, **3**, 155-157 **(2007)**.

[4] Wang Hong-da, Hao Yi-ge, Wang Ding-wei; Seasonal commodity pricing model and algorithm, Journal of Northeastern University (NATURAL SCIENCE EDITION), **1**, 23-25 **(2007)**.

[5] Guan Zhen-zhong; the history of the customers choice model of perishable product revenue management ordering and pricing strategy based on, systems engineering theory & practice, **9**, 47-53 **(2007)**.

[6] Liu Xiao-feng; Strategic consumers dynamic pricing and return the contract design, Journal of Zhongnan University of Economics and Law, **3**, 128-133 **(2008)**.

[7] Huang He, Xu Hong-yan et al.; Analysis, Journal of Chongqing University of Supply Chain Coordination Of A Short Life Cycle Product Dynamic Pricing (NATURAL SCIENCE EDITION), **6**, 150-154 **(2007)**.

[8] Liu Xiao-feng, Huang Pei; Strategic consumers optimal dynamic pricing and inventory decisions founded on, Journal of management science, **10**, 18-26 **(2009)**.

[9] Liu Jian, Luo Chun-lin; Fuzzy decision and variational method dynamic pricing for perishable products built on, Technology and management, **7**, 18-26 **(2009)**.

[10] Li Gen-dao, Xiong Zhong-kai, Nie Jia; Perishable products with demand dynamic pricing, Journal of Systems Management of Inventory and Price, **8**, 402-409 **(2009)**.

[11] R.Bitran, S.Caldentey, Mondschein; 1998, Coordinating clearance markdown sales of seasonal products in retail chains, Operations Research, **46(5)**, 609-624.

[12] Y.S.Zhao, Zheng, 2000, Optimal dynamic pricing for perishable assets with nonhomogeneous demand, Management Science, **46(3)**, 375-388.

[13] I.L.Bitran, R.Caldentey, Vial； 2005, Pricing policies for perishable products with demand substitution, Working Paper,MIT.

[14] W.L.Zhang, Cooper, 2008, Pricing substitutable flight in airline revenue management,

[15] European Journal of Operational Research,Forthcoming.

[16] Y.Aviv, A.Pazgal; 2008, Optimal pricing of seasonal products in the presence of forward-looking consumers, Manufacturing & Service Operations Management, **1(4)**, 1-21.

[17] G.Lai, L.G.Debo, K.Sycara; Buy now and match later, Impact of posterior price matching on profit with strategic consumers, Manufacturing & Service Operations Management, **25(1)**, 1-23 **(2009)**.

[18] G.Gallego, G.Van Ryzin, 1994, Optimal dynamic pricing of inventories with stochastic demand over finite horizons, Management Science, **40(8)**, 999-1020.