RESPONDING TO A ONE -TIME -ONLY SALE (OTOS) OF A PRODUCT SUBJECT TO SUDDEN OBSOLESCENCE

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ABSTRACT

With advancing technologies and shrinking life cycles, today many products are subject to sudden obsolescence. Manufacturers and vendors of products that are subject to sudden obsolescence often announce a one-time-only discount on these products. In this paper, we study a retailer's optimal response to such one-time-only sales (OTOS) of products subject to sudden obsolescence. We build a comprehensive model based on two relevant bodies of literature: the literature on one-time-only sales of non-perishable, non-obsolescent products, and the literature on inventory and pricing decisions for obsolescent products in the absence of any one-time only considerations.

Our model allows for price elasticity, accounts for a various types of inventory holding costs, and deals with obsolescence costs and capital costs separately from the holding costs. Our model also allows for the ordering cost of the special one-time only order to be different from the retailer's regular ordering cost. The model is general enough to accommodate non-obsolescent as well as obsolescent products in situations that do or do not involve an OTOS. A numerical example shows that the use of our model can provide some long-term gain and a particularly attractive short-term improvement in a retailer's profit. Sensitivity analysis shows that the benefits of our model are greatest when the discount is sizable; demand is highly price sensitive; and the retailer's ordering cost for the special order is small.

INTRODUCTION

With rapid advances in technology, abrupt changes in global political situations, and instantaneous dissemination of information in the worldwide market, today product life cycles have decreased dramatically, and a number of products are at risk of becoming obsolete overnight. Swiss watches, computer chips, world maps, breast implants, and Milli Vanilli records are some of the classic examples of this phenomenon.

For prudent inventory and pricing decisions on products subject to sudden obsolescence (hereafter called S-Obs products), a retailer must account for the costs of obsolescence carefully. Traditionally, obsolescence costs were treated as a component of the holding costs in the economic order quantity (EOQ) model (Hadley and Whitin 1963; Naddor 1966; Silver and Peterson 1985).

Then, some authors dealt with obsolescence costs separately from other inventory carrying costs (Barbosa and Friedman, 1979; Brown, 1982; Hill, Girard, and Mabert, 1989). However, these early works were focused on gradual rather than sudden obsolescence.

Masters (1991) defined sudden obsolescence as a situation when a product's lifetime is negative exponentially distributed, and consequently, the probability of obsolescence is constant at any time. Using an approximate model, Masters (1991) concluded that for S-Obs products, the use of the EOQ model was appropriate, provided that the obsolescence component was computed as the reciprocal of the product's expected life. Joglekar and Lee (1993, 1996) pointed out that the then current industry practice of estimating annual obsolescence costs at 1 to 3% of a product's cost represented a serious underestimate of the true cost. By Master's (1991) formula even a 3% obsolescence cost implies an expected life of 33 years! Joglekar and Lee (1993) showed that Masters' model also underestimated the true lifetime costs of his optimal policy while overestimating the optimal order quantity. The associated errors were substantial particularly in the cases of S-Obs products with very short expected lives. Joglekar and Lee (1996) developed a profit maximization model to determine a retailer's optimal order quantity in the face of a manufacturer's quantity discount for S-Obs products.

Not too different from situations of quantity discounts are the commonly observed situations of one-time-only sales (OTOS) of many products. An OTOS occurs because a manufacturer/wholesaler wants to reduce some excess inventory caused by factors such as incorrect forecasts, deliberate excess production, or the threat of impending obsolescence. OTOS allow manufacturers to pass on reduced raw material costs to the reseller, to meet short-term sales goals, to maximize capacity utilization, and/or to add excitement to otherwise mature and mundane products (Abad, 2003). Aucamp and Kuzdrall (1986) have also observed that the situation of an announced permanent price increase, with one last opportunity to buy before that price increase, is mathematically equivalent to an OTOS. Fashion clothes, pop music, and trendy toys are examples of S-Obs products where at the time of a product-introduction, a manufacturer often offers a substantial one-time-only discount to the retailer. Yet, available literature has not studied a retailer's optimal response to such OTOS offers for S-Obs products.

On the other hand, how a retailer should respond to an OTOS of a non-perishable, non-obsolescent product has been studied by a number of authors over the last three decades. Using standard EOQ assumptions, earlier works (Naddor, 1966; Brown, 1967; Tersine and Grasso, 1978; Taylor and Bradley, 1985; and Lev and Weiss, 1990) developed prescriptive models for determining an optimal special order quantity for a retailer in a variety of OTOS situations. These works assumed a constant demand. Considering price-elasticity, Ardalan (1994 and 1995) suggested that, in OTOS situations, in addition to using a special order quantity, a retailer could increase his demand and profits by charging a lower retail price for it. Ardalan (1994) also focused on maximizing the net present value (NPV) of a retailer's cash flows rather than maximizing the per-period profit.

In this paper, we combine Joglekar and Lee's (1996) methodology of analyzing order quantity decisions pertaining to S-Obs products with Ardalan's (1994) approach of simultaneously determining the special price and the special order quantity in the face of an OTOS. First, we develop a model for a retailer's optimal price and order quantity decisions for a price-sensitive S-Obs product in the regular situation, i.e., in the absence of an OTOS. Our model allows for price elasticity, accounts for various types of inventory holding costs, and deals with obsolescence costs and capital costs separately. Next, we extend the regular situation model to accommodate an OTOS situation. Unlike other available models, we do not assume that a reseller's cost of ordering the special quantity in an OTOS situation will be the same as his regular cost of ordering. We believe that decision-making under special circumstances requires a new model, additional data and greater analytical effort. Hence, the cost of ordering the special quantity is often substantially greater than the regular ordering cost. In order to obtain an accurate estimate of the net advantage of our model's optimal decisions, we use a comparison of the lifetime NPV of the no OTOS situation with the lifetime NPV of a situation involving an OTOS. To gain a clearer perspective on the long term and short-term significance of the net advantage, we look at the net advantage as both, percentage of lifetime NPV and percentage of one cycle NPV.

In this conference proceedings version, we cannot present all the details of our model. Instead, we present only our numerical examples and sensitivity analysis. Our analysis shows that, in many OTOS situations, the use of our model can provide some long-term gain and a particularly attractive short-term improvement in the retailer's NPV. Our model can also identify situations where the retailer may be better off not accepting the OTOS discount. A retailer stands to benefit the most from our model if the discount is substantial, the product demand is highly price sensitive, and the retailer's ordering cost for the special order is substantial. Also, it seems that OTOS decisions are more beneficial for non-obsolescent products than they are for obsolescent products.

THE NOTATION

In order to understand our numerical examples, the reader needs to understand the following notation.

A	a constant for the demand function, representing the theoretical maximum demand at zero price
c	retailer's regular unit cost
Cr	retailer's regular ordering cost per order
Cs	ordering cost per order during special cycle

Note: We believe that the commonly used assumption Cs = Cr is unrealistic. Cs is likely to be substantially greater than Cr for three reasons: (i) OTOS policy determination requires the use of a different model, (ii) The OTOS order quantity is likely to be several times the regular order quantity, and (iii) Cs must also include costs of announcing the special retail price, Ps to the retailer's customers.

d	the OTOS discount per unit
H	annual holding costs (such as storage space, and material inspection and handling costs) that are fixed per unit, regardless of the unit cost of the product.
h	annual holding costs (such as deterioration, damage, and pilferage costs) that are fixed per dollar of inventory, but that vary in per unit terms with the unit cost of the product.
	Note: Most inventory models assume all holding costs to be of either the H type or of the h type. In real life, one encounters both types. Note also that we deal with the obsolescence costs and the capital costs explicitly and separately. Consequently, neither H nor h includes them.
i	cost of capital per dollar per year (used as both, the cost of capital factor in the inventory holding cost and the discount rate for NPV calculations).
L	expected life of the product in years
Pr	selling price per unit during regular cycle prior to obsolescence
Ps	selling price per unit during special cycle prior to obsolescence
Qr	order quantity per order during regular cycle
Qs	order quantity for the OTOS special order
Rr	demand per year during regular cycle, given by the function Rr = A - ePr.
Rs	demand per year during special cycle, given by the function Rs = A - ePs.
So	salvage value per unit after obsolescence, So < (c - d).
DpL	the difference between the expected lifetime profit resulting from the special OTOS Ps and Qs policies followed by all regular cycles and the expected lifetime profit of all regular cycles in the absence of an OTOS. DpL = pLs - pLr.
e	price-elasticity constant of the demand function
pcr	expected profit, in NPV terms, from the first regular inventory cycle
pLr	expected lifetime profit, in NPV terms, from all regular cycles
pcs	expected profit, in NPV terms, from the special OTOS cycle
pLs	expected lifetime profit, in NPV terms, from the special OTOS cycle followed by all regular cycles

NUMERICAL EXAMPLE

Table 1 presents a "base case" numerical example. The Assumptions section of Table 1 lists all the assumptions of this numerical example. We believe the assumed parameter values are fairly realistic. As Table 1 shows, under our parameter values, in the regular situation, the retailer's optimal retail price works out to be $13.43/unit. The corresponding demand is 19,419 units/year, and the optimal order quantity is 516 units/order (or less than two weeks' supply). These optimal decisions result in a regular cycle profit (in NPV terms) of $1,545 and a lifetime NPV of $52,706.

Now, assume that the manufacturer has offered an OTOS discount of $1/unit (i.e., 10% of the regular unit cost), available at the time of the retailer's next order. Also assume that because it requires the use of a different model and involves the need to communicate a special price to the customers, the retailer's ordering cost for the special order, is $500, instead of the regular $100. Table 1 shows that, in this situation, the retailer's special order quantity would be 2,097 units and his special selling price would be $13.16/unit. Given the special price, during the OTOS cycle, the retailer would experience a demand rate of 21,031 units/year. Thus, the special order quantity will last for approximately five weeks. The retailer's profit (in NPV terms) from the OTOS cycle will be $6,456.

However, this special cycle NPV is not directly comparable with the regular cycle NPV of $1,545 since the two cycles involve different lengths of time. The product's lifetime NPV from the special cycle followed by all regular cycles is $53,592. Thus, the retailer's net increase in lifetime NPV due to the OTOS is $886. In comparison to the NPV of all regular cycles ($52,706), this net advantage looks small (1.68%). However, $886 is 57% of a single regular cycle's NPV of $1,545. This short-term advantage is very attractive. After all, the OTOS decisions are short term, one-cycle decisions. In short, our numerical example shows that if a retailer adopts our model, he would obtain some long-term gain and a particularly attractive short-term gain.

Of course, conclusions from a numerical example are only as valid as the assumed parameters. Hence, in what follows, we provide an analysis of the sensitivity of our results to each one of the assumed parameters. The numerical example in Table 1 serves as the base case for this sensitivity analysis.

SENSITIVITY ANALYSIS

The only parameter we hold constant throughout the sensitivity analysis is the retailer's regular unit cost of the product. However, changes in some of the other parameters could be seen as relative changes in the unit cost.

Holding other assumed parameters at their values in Table 1, in Table 2 we vary the assumed amount of discount offered by a supplier to the reseller. As can be seen, when the discount is only $0.40 (or 5% of the normal unit cost), using special OTOS policies would result in a net loss to the reseller. Thus, the reseller is better off continuing to use his regular policies during the OTOS period and simply benefiting from the windfall gain from the discounted cost. However, as the amount of discount (and its percentage of normal unit cost) increases, the OTOS strategies become increasingly attractive, both, from the long term and the short-term perspective. When the discount is as large as 25% of the normal unit cost, the reseller may want to use a special order quantity that is 8 times his regular order quantity and pass on more than a fourth of his unit cost saving to his customers. Such a one-time opportunity can increase the reseller's lifetime NPV by 7.66% and his single cycle net advantage can be several times his normal single cycle profit.

Similarly, we carried out a detailed examination of the sensitivity of our results to each one of the parameters of our model. In Table 3, we provide a brief summary of the alternative values of parameters used, the resulting indices of long term and short-term advantage of the optimal OTOS strategies. From Table 3 it should be clear that a retailer stands to benefit the most from our model if the discount is substantial, the product demand is highly price sensitive, and the retailer's ordering cost for the special order is substantial. Also, it seems that OTOS decisions are more beneficial for non-obsolescent products than they are for obsolescent products.

Note: A complete version (including the model, the conclusion, tables and the references) of this manuscript is available from the corresponding author.