Quantity discounts; how big should they be?

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Abstract

While most market-oriented pricing schemes include offers of quantity discounts, their size is generally decided on arbitrarily. This article discusses the various possible marketing objectives of quantity discounts and argues that valid methods for calculating appropriate schedules should be linked to these objectives. Using a specific case study, the practical application of this approach is illustrated.

Key words
Marketing, Quantity Discounts, Product Pricing

INTRODUCTION

Granting quantity or volume discounts for large orders is one of the most universal of marketing practices. Yet while virtually every standard marketing text recommends their use, almost no guidance is offered as to exactly how large they should be. Even more advanced texts devoted specifically to pricing offer little more help. Gabor, for example, concludes his discussion of the topic as follows;

> "Since quantity discounts are partly expressions of cost savings and partly of a promotional nature, it is not possible to lay down any general principles for the determination of their magnitude." (Gabor 1985, p.105)

While this is still true, the object of this article is to consider how to go about analyzing quantity discount issues in a variety of circumstances. This seems to be particularly relevant since their application in practice appears to continue to produce inconsistent performance. For example, a study by Adesso Solutions (2005) reports that less than 10% of suppliers felt that their discount and promotion schemes were managed effectively. The approach suggested is illustrated to devlop a quantity discount schedule for a small business with which the author is familiar.

LITERATURE REVIEW

As Lal and Staelin (1984) pointed out nearly twenty years ago, the literature on how a *buyer* should react to a given quantity discount schedule is more substantial than on how a *seller* should design the quantity discount schedule in the first place, and this situation remains essentially the same today. The former body of work concentrates on calculating the necessary adjustments to the well-established theory of economic order quantities (EOQ's) in response to different quantity discount schedules (Duncan 1976; Weng 1995; Bogner, Wong and Price 2002).

In one of the earliest analyses of the problem seen from the seller's point of view, Crowther (1964) adopts the EOQ approach to design an optimum quantity discount schedule. His methodology takes into account both the costs of obtaining an order and also of holding

inventory, but it does not consider potential marketing advantages. Because of some of its simplifying assumptions, Monroe and Della Bitta (1978) in their review article on the topic describe Crowther's approach as 'flawed' (Monroe and Della Bitta 1978, p. 424) and suggest some refinements. Rao (1980) considers the factors which necessitate organisations to modify quantity discounts periodically in response to changing market conditions. In particular, he considers how they should respond to the impact of inflation, mergers among buying organisations, and increasing buyer sophistication on the design of discount structures.

Lal and Staelin (1984) generalise the earlier models to include many buyers with differing costs and final demand for the product. These authors, following the earlier EOQ approach, look at the rationale for volume discounts as a means of shifting inventory from an upstream channel member to a downstream one. An important limitation of this approach, as the authors themselves admit, is their assumption that the overall annual demand for the seller's product is given and not affected by the quantity discount scheme developed. The analysis is therefore based on reducing the seller's order processing, shipping and inventory costs by shipping a given quantity of product in fewer larger consignments. Their model calculates an optimal quantity discount scheme, which provides the necessary incentives to buyers acting in their own self-interest. Dolan (1987) reviews both the marketing and economic literature on quantity discounts and examines their application in four individual cases, each of which illustrate the different motivations behind their application. The paper shows how these discounts can be used strategically to increase seller profitability. Dolan observes that marketing managers have at best a vague understanding of quantity discounts and wonders whether in some cases the price structures are unnecessarily complex, particularly if the costs of implementation are fully considered. He concludes that that application of economic and marketing analysis can make a relevant and unambiguous contribution.

Lambert, Bennion and Taylor (1990) refer to quantity discounts (or volume discounts in their nomenclature) in the context of 'The Small Order Problem' and point out that a well-designed system establishes an economic justification for the use of wholesalers. Wilcox, Howell, Kuzdrall and Britney (1987) suggest that quantity discounts give buyers opportunities to order larger quantities than they need and enter into pre-arranged resale agreements to brokers. They suggest that this practice could account for the emergence of 'gray markets' in certain

circumstances (one of which would seem to be very large discounts for the practice to be economically attractive). Blois (1994) discusses quantity discounts in both theory and practice and concludes that a well-planned discount structure can be of great tactical and/or strategic benefit to a supplier. Simon and Dolan in a review of 'price customisation' strategies (of which quantity discounts are a particular example) note that it is 'the element of the marketing mix with the greatest degree of missed opportunity' (Simon and Dolan 1998, p.10).

Sadikoglu (2006) develops a procedure for determining an optimum discount schedule to obtain a specified cost saving determined through prior negotiation between a single buyer with known annual demand. It considers savings from reduced order costs being partially offset by additional inventory carrying costs to produce the agreed annual cost saving. The multiple buyer approach is also considered and a heuristic approach to developing appropriate discount schedules in these circumstances. Altintas, Erhun and Tayur (2008) consider the value of discounts in reducing transportation costs and propose an effective design of discount schemes in a multiperiod setting under stochastic demand.

Subramaniam and Gal-Or (2009) consider quantity discounts given to final consumers offered differentiated products by competing sellers. Optimal non-linear pricing rules are derived and they find that the extent of discounting declines the less differentiated the products.

DEFINITION AND USE OF QUANTITY DISCOUNTS

For the purpose of this discussion, a quantity discount is defined as a discount that is applied according to the size of an *individual* order. By contrast, discounts that are based on the sales total cumulated from a number of *different* orders from a specific customer are more properly defined as 'loyalty rebates' even if they are often not referred to as such. In any case they are excluded from this analysis.

Although the expression 'quantity discount' might suggest otherwise, the term is generally defined in relation to the *monetary value* rather than the *physical quantity* of merchandise bought. While some authors object to this practice on the grounds that it means that the real value of the discounts automatically increase with inflation, the use of value rather than quantity measures is the most practical way to apply quantity discounts in firms that sell a variety of products at different prices. This

means, however, that the sales levels at which the discounts apply may need to be adjusted occasionally to reflect the effects of inflation.

Quantity discounts are a common feature of pricing policies because they offer sellers the opportunity to increase efficiencies in production, inventory management, and marketing by receiving orders of a larger average size than would otherwise be the case. At the same time, buyers, as well as receiving the discount, may make economies in their ordering process which more than offset any increased inventory holding costs and other diseconomies that result from placing fewer larger orders. The prevalence of quantity discount schemes in all types of markets reflects the willingness of both buyers and sellers to share these gains.

While it is certainly true that the design of an optimum quantity discount scheme is difficult, it is possible to develop tools for analysing specific marketing situations and providing guidance to decision makers. To do this, the starting point is to look at the precise objectives a discount scheme is being designed to achieve. These may be several and varied, as is illustrated by the list shown in Table 1.

Place Table 1 about here

It is because of these various motives behind the use of quantity discounts that the construction of a general theoretical approach, as the literature review suggests, has proved so elusive. The model proposed here and the accompanying case study does not attempt to fill this gap. Rather it suggests that a clear understanding of the precise objectives of a quantity discount scheme in any specific marketing situation are an essential first step towards determining the most appropriate structure for it. The specific application of the approach described here is one in which the seller wishes to use a quantity discount scheme allocate his marketing efforts optimally between different customers. It is therefore essentially a *marketing management* rather than an *inventory management* tool and, as such, may have sufficiently common application for its design and results to be of general interest.

THE CASE STUDY

The methodology that is described here was developed to calculate a quantity discount schedule for a small company based in the United States, producing a line of up-market consumer products. The author was a seed investor in the company and consulted extensively for it in relation to its marketing activities. The author's interest in this topic was aroused by the fact that he was asked to provide the founding entrepreneur with advice on how to set quantity discounts in a real-life (and perhaps fairly common) type of marketing situation. When his review of the literature outlined above revealed the absence of a suitable 'off-the-shelf' methodology for addressing the problem, he was inspired to attempt to address it directly by applying an original approach. This case study therefore represents the author's effort at providing a 'real life' solution to a 'real life' problem. The assumptions made in it are not arbitrarily chosen to suit the use of some particular methodology. Rather they are based on the author's own assessment of the marketing environment the company faced and his direct personal knowledge of the company's internal marketing manufacturing and logistics cost structures.

As is probably common, the founding entrepreneur behind the company developed pricing policies based primarily on a cost-plus model. Distribution is exclusively through specialist retailers for whom the products are durable accessory items that represent a small part of their total turnover most of which comes from related consumable products. The company supplies most of the retailers directly, but some of the more distant and smaller retailers are served by a specialist wholesaler.

The company faces limited economies of scale in manufacturing, much of which is subcontracted and production follows standard designs even if the items are available in various colours etc. and are not in general customised for particular retailers or consumers. The firm may achieve some economies of scale related to its overall volume of business and these would accrue primarily through being able to buy raw materials and components more economically as well as spreading its overheads more widely. Limited raw materials and components inventories are maintained but final assembly is generally scheduled against the receipt of firm orders. This can be accomplished quite quickly using sub-contracted labour and goods are then shipped to the distribution channel immediately. Finished goods inventories are therefore generally kept very low.

The company believes that the price elasticity of demand for its products among final customers is low for the following reasons;

1. The products are luxury items that have unique features that distinguish them from competition.
2. The products are sold as accessories to users of an associated high-priced consumable product that appeals to high income, status-conscious consumers.
3. The products are often bought as gifts. Both for giver and receiver, the prestige associated with the products' brand and its price are important.

The company therefore wishes to preserve an up-market luxury image for the product. While there might be some significant price elasticity among retailers who are responsive to 'a deal', the company does not want this to be reflected in price discounts at the retail level. These would result from retailers applying the 'standard mark-up' policy and would conflict with the objective of maintaining the exclusive luxury image of the product . It would also likely provoke objections from other retailers carrying the product at the 'normal' retail price and might result in them replacing the line with accessories produced by another manufacturer.

In this situation, therefore, the primary reason for offering quantity discounts relates to objective four in Table 1 - that is to set quantity discounts that would lead to an optimal allocation of sales and marketing effort between those customers who commonly place large orders and those who commonly place small orders. Doing this means that the firm is indifferent between making the same overall sales from receiving a large number of small orders from smaller retailers and a smaller number of large orders from larger retailers and the wholesaler. This implies that the net profit margin on any size order of should be equal once the direct selling and transaction costs associated with receiving and fulfilling it have been deducted.

Expressed algebraically the appropriate formula is;

(1) $NP = GP - D_V - S_V / V = \text{Constant for all } V$

where;

NP = Net Profit per sales dollar after deducting quantity discounts and selling, distribution and administration costs.

GP = Gross Profit per sales dollar at non-discounted prices. That is the difference between the regular wholesale price and the variable costs associated with its manufacture.

D_V = Quantity discount available on orders above dollar value V

$S_{V.}$ = Selling, administration and distribution costs associated with an order of dollar value V.

V = Value of order placed before applying the quantity discount.

In this case appropriate values in the formula can be calculated through considering established practice with the firm's largest customer, a major wholesale distributor that receives a 40% discount on the regular price, which is the standard for all distributors in the industry. This distributor then sells to retailers at the same prices as those offered to the firm's smallest customers, i.e. without offering any quantity discounts at all. Retailers are encouraged to offer the products to the final purchaser at a 100% mark-up on the non-discounted price. These practices are designed to preserve as far as possible price uniformity at the retail level by discouraging price competition among the retail stockists, even though US law prevents outright enforcement of retail prices determined by manufacturers.

The average order value from the major wholesale distributor was equivalent to $100,000 valued before receiving their forty per cent discount. The average order received directly from the small retailers was approximately $1,000. Thus;

(2) $D_{100,000} = 0.4$

(3) $D_{1,000} = 0$

The firm's gross profit (GP) before any discounts was 64%. So substituting in equation (1) for the major distributor and the small retailers respectively;

(4) $NP = .64 - .4 - S_{100,000} / 100,000$

(5) $= .64 - 0 - S_{1,000} / 1,000$

The firm estimated that the selling, administration and distribution costs were ten times larger for the major distributor than for the small retail customers, i.e.;

(6) $S_{100,000}, = 10 * S_{1,000}$

Substituting in equations (4) and (5) and reorganising;

(7) $NP = .64 - .4 - (10 * S_{1,000}) / 100,000 = .64 - 0 - S_{1,000} / 1,000$

(8) $.24 - S_{1,000} / 10,000 = .64 - S_{1,000} / 1,000$

(9) $S_{1,000} * (1/1,000 - 1/10,000) = .4$

(10) $S_{1,000} = .4* (10,000/9)$

$= 444.44$

(11) $NP = .64 - (444.44/1,000)$

$= .1956$

The implied cost of fulfilling the smallest orders is therefore $444 and the implied cost of fulfilling the largest orders is $4444. The net profit per sales dollar (NP) after deducting the quantity discount and selling costs is approximately 20% on both small and large orders.

Having considered the two extreme cases, it is now necessary to estimate the cost of selling, distribution and administration (Sv) associated with orders whose size falls between these limits. To do this, a mathematical formula was used that reflects a reasonable relationship between selling costs and order size. Note that in the above example the company assumes that a $100,000 order involved ten times the selling costs associated with a $1,000 order. This suggests a quadratic relationship of the form:

(12) $S_V / S_{1000} = \sqrt{(V / 1000)}$

Equation (1) can then be rearranged and this formula substituted into it.

(13) $$Dv = GP - NP - Sv/V$$
$$= GP - NP - (S_{1000} * \sqrt{(V / 1000)})$$

Using these equations and assumptions, a spreadsheet (Table 2) was constructed to calculate the quantity discount appropriate for any size order. This shows results for various order sizes including the $1,000 and $100,000 examples already considered.

Place Table 2 about here

One way of using this spreadsheet would be to determine a discount associated with any order at the time it is placed by entering the specific non-discounted value (V) in the appropriate column and then telling the retailer what level of discount he will receive. Customarily, however, quantity discounts are offered at fixed rates that apply in bands defined either in terms of the unit quantity or the dollar value of an order. Once an order reaches a higher band size the next level of discount is applied across all items ordered. Gabor (1985) points out that this can lead to situations where the total dollar value of an order can actually *decrease* as its size increases. While it might be more logical to apply the discount only to that part of the order that exceeds the relevant threshold rather than the *whole* order, such quantity discounts schemes are rarely used in practice. This is probably because they are much more difficult to explain and customers often feel that any scheme that does not apply the discount equally to *every* item on their order is inherently unfair.

Also, setting the bands at a point somewhat above the customary order size for groups of customers can achieve the advantage of encouraging them not only to place the same amount of business in fewer larger orders but also to increase the overall amount of business placed. Doing this will achieve advantages with the regard to the second objective shown in Exhibit 1, that is to encourage a pre-emptive push of inventory down the channel of distribution at the expense of competitors' offerings. Using this approach to indicate the appropriate placement of the discount bands involved examining the firm's existing distribution of order sizes to determine suitable 'incentive points'. These were

chosen to be above typical order sizes by an amount that was significant but not so great that a skilled salesperson could not persuade the retailer that it would be worth purchasing more in order to reach the next 'band'. Applying this approach resulted in choosing $2,000, $5,000, $10,000, $20,000 and $50,000 as being appropriate points for applying higher levels of quantity discount, and the calculations associated with them are shown in Table 2.

DISCUSSION AND CONCLUSIONS

Examination of the optimal discount column (D_v) suggests the following conclusions;

1. A fairly large discount should be offered to increase the size of the smallest orders since these were clearly very expensive to fill in relation to their size. The table suggests 13%, and the firm decided for simplicity to round this up to 15% for orders above $2,000.
2. Similarly, discounts on orders above $5,000, $10,000 and $20,000 were fixed at 25%, 30% and 35% respectively.
3. Finally, since the recommended discount of 38% on orders above $50,000 was so close to the maximum discount of 40%, the firm agreed to begin offering the 40% rate at the $50,000 level rather than the $100,000 level originally envisaged.

The above analysis suggests a way in which appropriate levels of quantity discounts can be determined given a particular set of assumptions about the size of individual customer orders and the costs associated with obtaining them. On the assumption that the cost of obtaining an order rises increasingly slowly above low volumes (i.e. the quadratic function adopted in equation 13) the optimum discount levels tend to follow a pattern somewhat different from those commonly adopted in practice. In particular, the recommended increases are quite steep between the smaller order bands but then become relatively small at the higher levels. The more typical pattern is for quantity discounts to rise in equal increments over quite a wide range of order values and such schemes probably reflect an arbitrary 'seat of the pants' approach that appears to be typically used in making these types of decision.

MANAGERIAL IMPLICATIONS AND DIRECTIONS FOR FUTURE RESEARCH

At present marketing managers seeking help from business scholars in designing quantity discount systems can expect very little from examining standard marketing texts which generally do little more than describing them without offering any advice on when and how to use them. However, even using the more rigorous approach advocated here, it would be a mistake to suggest that there is a single method of calculating quantity discounts that is guaranteed to produce a single right answer. What this approach *does* demonstrate is that by carefully defining the marketing objectives that volume discounts are intended to achieve and then modelling the costs and revenues associated with achieving those objectives, valuable input to marketing decisions can be provided. Even then, some flexibility should be maintained in the system to meet particular circumstances. For instance, in the above example, the company would probably not want to apply anything other than the highest discount level to 'top-up' orders from the large distributor who was already earning this rate on the remainder of its business. In any case, it would not be particularly logical to do so since presumably the marketing costs associated with such customer initiated orders would be very low.

In general, it is suggested that Marketing Managers should ask themselves the following questions before initiating a totally arbitrary system (as often seems to be the case);

1. What system of quantity discounts is our firm currently using?
2. What are the objectives that this system is supposed to achieve?
3. Does it achieve them?
4. Using the type of methodology suggested in the paper can a superior system be developed?

Meanwhile, although marketing scholars may not be able to offer a general theory of quantity discounts, continued research in this field should provide useful tools. A valuable avenue of future research would be to survey marketing managers in various industries to find out their answers to the first three questions in the above list. Such empirical research would also very likely confirm that most firms have never thought seriously about the design of their discount systems in a rigorous manner. Based on their responses, approaches to answering the fourth question in the above list could then be developed. Some twenty years after Dolan, research in this area still offers 'the delightful duality of intellectual stimulation and managerial relevance' (Dolan,1987, p.22).

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TABLE 1

POSSIBLE OBJECTIVES OF QUANTITY DISCOUNTS

1. To encourage large purchases of items in circumstances in which there are significant economies of scale in production applicable to individual orders.

2. To shift inventory down a channel of distribution by encouraging infrequent large orders rather than frequent small orders. In this case, the object may be not only to reduce inventory holding costs but also to pre-empt purchases of competitors' products. If this is so, the use of quantity discounts will not only increase the average order size but also increase the total volume sold.

3. To exploit greater price elasticity of demand among large customers as opposed to small customers.

4. To reflect the lower *per unit* selling and distribution costs associated with winning and fulfilling large orders as opposed to small orders.

TABLE 2

SPREADSHEET FOR CALCULATING QUANTITY DISCOUNTS

V	Sv	S_V / S_{1000}	GP	NP	Dv
$1,000	$444	1.00	64.0%	19.6%	0.0%
$2,000	$628	1.41	64.0%	19.6%	13.0%
$5,000	$993	2.24	64.0%	19.6%	24.5%
$10,000	$1,404	3.16	64.0%	19.6%	30.4%
$20,000	$1,986	4.47	64.0%	19.6%	34.5%
$50,000	$3,140	7.07	64.0%	19.6%	38.1%
$100,000	$4,440	10.00	64.0%	19.6%	40.0%