

Unraveling quantity discounts[☆]

Fredo Schotanus^{a,*}, Jan Telgen^a, Luitzen de Boer^b

^aDepartment of Operational Methods for Production and Logistics, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

^bDepartment of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 1, Sentralbygg II, N 7491 Trondheim, Norway

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Abstract

We consider the situation in which a buying organization deals with a discrete quantity discount schedule offered by a selling organization. Furthermore, the buying organization can negotiate with the selling organization about the lot size and purchase price, but does not know the underlying function that was used by the selling organization to determine the quantity discount schedule. In this paper, we provide an analytical and empirical basis for one general quantity discount function (QDF) that can be used to describe the underlying function of almost all different quantity discount types. We first develop such a QDF analytically. Among other things, this QDF enables buying organizations to calculate detailed prices for a large number of quantities. We subsequently show that the QDF fits very well with 66 discount schedules found in practice. We discuss that the QDF and related indicators can be a useful tool in supplier selection and negotiation processes. It can also be used for competitive analyses, multiple sourcing decisions, and allocating savings for purchasing groups. Additionally, the QDF can be included in research models incorporating quantity discounts. We conclude the paper with an outlook on further QDF research regarding the characterization of commodity markets from a demand elasticity point of view.

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1. Introduction

Quantity discount schedules have been used widely for many centuries [1]. These days, quantity discount schedules come in all shapes and sizes. A typical example of a discount schedule is shown in Table 1 [2]. This discrete schedule provides the price per item for a limited number of quantities and prices. It does not

provide the assumed function which the supplier used to calculate the price per item. Therefore, it is difficult for a buying organization to calculate negotiable prices for the many possible quantities for which no specific prices are provided by the supplier. For instance, if a buying organization needs a quantity of 9500 items, then the question often is what price—in between 40.9 and 45.4—the buying organization can start negotiating with. Another question is whether the buying organization should start negotiations with supplier A (see Table 1) or supplier B (see Table 2) for a quantity of 9500 items.

As a result of this information deficiency, it is difficult for buying organizations to compare quotes of different suppliers and to determine negotiating spaces.

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* Corresponding author. Tel.: +31 6 1209 4702;

fax: +31 53 489 2159.

E-mail addresses: f.schotanus@utwente.nl (F. Schotanus),
j.telgen@utwente.nl (J. Telgen), luitzen.de.boer@iot.ntnu.no
(L. de Boer).

Table 1
Example of a discount schedule of supplier A [2]

Quantity	Price per item
1000–4999	50.0
5000–9999	45.4
10,000–29,999	40.9
30,000–49,999	38.1
50,000–199,999	37.1
200,000 and more	33.5

Table 2
Example of a discount schedule of fictional supplier B

Quantity	Price per item
500–999	51.0
1000–1999	49.0
2000–3999	47.0
4000–7999	45.0
8000–15,999	43.0
16,000 and more	41.0

In this paper, one of our aims is to tackle this information deficiency problem. We do this by deriving the quantity discount function (QDF) that the supplier used to calculate the price per item. With this QDF, a buying organization can calculate prices for all possible quantities. But more importantly, the QDF derived can be used as a basic ingredient in research models incorporating quantity discounts. Before we discuss more applications and the academic and practical relevance of the QDF in more detail (Sections 1.2 and 1.3), we shortly introduce some important insights into quantity discounts in Section 1.1.

1.1. Relevant knowledge base on quantity discounts

First of all, calculating prices for all possible quantities is only a useful practice if the purchase price is negotiable. According to Munson and Rosenblatt [3], this is true for most situations. They argue in their study that purchase prices and lot sizes are mostly determined through negotiations. Munson and Rosenblatt also note that quantity discount schedules may have different characteristics:

- The number of price breaks in a discount schedule may be one, two, multiple or infinite [2,4].
- The form may be all-items or incremental. An all-items form means that all items receive the same

discount [5]. An incremental form means that only the items within a price break interval receive that interval's discount [5].

- Time aggregation may be individual or multiple. This describes whether the discount applies to individual or multiple purchases over a certain time period [3].
- And finally, discounts may apply to one or multiple items [3].

The economic rationales of quantity discounts are mainly three-fold:

- Achieving perfect price discrimination against a single customer or a set of homogenous customers or achieving partial price discrimination against heterogeneous customers [6].
- Influencing the buying organization's ordering pattern to coordinate the supply chain [7] or to increase the logistics system efficiency in a distribution channel [8].
- And often, buying organizations are simply expecting a certain quantity discount for purchasing large amounts [9].

The body of knowledge on different types of quantity discounts is large, both from the seller's perspective and from the buyer's perspective. From the seller's perspective, a great deal has been written about when suppliers should offer quantity discounts, and if so, what type of quantity discount schedule they should offer to maximize profits (e.g., [10]). From the buyer's perspective, a great deal has been written about the application of quantity discounts in economic order quantity (EOQ) models (e.g., [11]) and inventory ownership problems (e.g., [12]).

Nearly all the previous research on quantity discounts is focused on creating quantity discount schedules or applying discount schedules in new or existing models. We use a different perspective. Given a quantity discount schedule, we are interested in deriving the supplier's original function that was used to create the schedule. Up to now, very little is known on deriving a QDF from a quantity discount schedule.

A given discount schedule (see Table 1 for an example) provides an indication of potential price discounts. For instance, Table 1 provides an indication of potential price discounts for five price breakpoints. For buying organizations, this in itself is useful information for supplier comparison and negotiations. A QDF, however, can provide more information. In the next sections, we discuss the academic and practical relevance of a QDF.

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