MARKETING SCIENCE INSTITUTE

Customer Profitability in a Supply Chain

Rakesh Niraj
Mahendra Gupta
Chakravarthi Narasimhan

Working Paper
Report No. 99-125
1999



We thank seminar participants in National Chengchi University, Taiwan, for their comments. Any remaining errors are solely our own.

MSI was established in 1961 as a not-for-profit institute with the goal of bringing together business leaders and academics to create knowledge that will improve business performance. The primary mission was to provide intellectual leadership in marketing and its allied fields. Over the years, MSI's global network of scholars from leading graduate schools of management and thought leaders from sponsoring corporations has expanded to encompass multiple business functions and disciplines. Issues of key importance to business performance are identified by the Board of Trustees, which represents MSI corporations and the academic community. MSI supports studies by academics on these issues and disseminates the results through conferences and workshops, as well as through its publications series.

This report, prepared with the support of MSI, is being sent to you for your information and review. It is not to be reproduced or published, in any form or by any means, electronic or mechanical, without written permission from the Institute and the author.

The views expressed in this report are not necessarily those of the Marketing Science Institute.

© 1999 Rakesh Niraj, Mahendra Gupta, and Chakravarthi Narasimhan

Customer Profitability in a Supply Chain

Rakesh Niraj, Mahendra Gupta, and Chakravarthi Narasimhan

As the ability to collect customer-level information increases and the cost of processing, storing, and retrieving such information drops, more and more firms—aside from the direct marketers who embraced this idea earlier—are adopting concepts such as one-to-one marketing, relationship marketing, and so on. Academics have suggested that an appropriate measure to focus on in such situations is that of customer equity, which is the sum of the lifetime value (LTV) of customers. LTV of a customer is the sum of the expected stream of net profits, properly discounted, from the customer over the lifetime of that customer with the firm.

To determine customer equity, a firm must: (1) compute current period profits at the customer level, (2) forecast a customer's propensity to stay with the firm over the next several periods, and (3) forecast the expected stream of revenues and costs of servicing this customer and therefore the net profits that would accrue over the customer's lifetime.

In this report, authors Niraj, Gupta, and Narasimhan develop a model to accomplish the first step, that is, to compute current level of customer profitability. Using activity-based costing (ABC), they develop a detailed cost model and utilize data from a supply chain to illustrate how it can be used to estimate current profits. The data come from a large distributor in the grocery industry and the model involves analyses of customer-level transactions over a period of one year.

Key Findings

- ❏ All customer dollars are not equal in their effect on the firm's net profits. Customers' different service needs result in widely varying profitability. In this study, 32 percent of customers were found to be unprofitable.
- ❏ While volume remains a very important indicator of profitability, customer service costs play an equally important role. Of the 13 largest customers in this analysis (all having revenue in excess of a million dollars), one was unprofitable and another was barely profitable for the distributor.
- ❏ Like many distributors, the distributor in this analysis provided discounts based on volume. However, since the true nature of service costs is often not understood, on average, larger discounts were given to relatively bigger customers than was warranted by service cost differential alone.

- Some cost-generating services are priced appropriately, while others are not. In this distributor's case, drop shipments were profitable; however, taking special orders and generating more frequent orders were largely money-losing propositions.

Implications

In adopting customer-focused initiatives like ECR (Efficient Consumer Response), both the overall impact on total channel costs and distribution among channel members need to be kept in mind. One of the two large customers in this sample that did not perform well in terms of profitability had recently shifted to ECR practices. Unless such initiatives are accompanied by higher volume of transactions or higher margins, a distributor might in effect incur higher costs that erode profitability.

Current customer profitability analysis may not be enough to make acquisition and retention decisions about individual consumers, but it is a necessary first step. If unprofitable and unpromising customers can be identified, dropping them may lead to substantial savings in costs, and scarce managerial resources can then be utilized to focus on the real prize customers of the firm.

Most importantly, information provided by customer profitability analysis can be used to devise incentives to influence external, i.e., customer, behavior to improve a firm's profit. Implementing a menu-based pricing scheme is one such incentive, ensuring that the customer fully compensates for the services used. Similarly, internal incentives could be better aligned so that the salesforce, for example, spends their effort in activities that are aligned with the firm's interests.

Rakesh Niraj is a doctoral student in marketing, Mahendra Gupta is Associate Professor of Accounting and Chakravarthi Narasimhan is Philip L. Siteman Professor of Marketing, all at the John M. Olin School of Business, Washington University in St. Louis.

Contents

Introduction 3

Background 5

Customer Profitability Model 9

- The Supply Chain 9
- Customer Profitability for the Distributor 10
- Price Premiums/Discounts and Effective Margins 13
- Tradeoffs and Interaction among Customer Characteristics 14

Data and Implementation of Customer Profitability Model 17

Empirical Analysis of Factors Affecting Customer Profitability 19

- Distribution 19
- Portfolio Analysis of Customers 19
- Price Premiums/Discounts and Effective Margin 20
- Correlation and Regression Analyses 21
- Large Customers 24

Conclusion 27

- Implications 27
- Limitations 29

Appendix 31

Notes 33

References 35

Tables

- Table 1. Activities in the Supply Chain 10
- Table 2. Distributor's Activities, Related Costs, and Allocation of Costs to Individual Customers 12
- Table 3. Profile of Customers 18
- Table 4. Size Portfolio of Customers' Mean Values and Ranges 20
- Table 5. Correlation and Regression Analysis 22
- Table 6. Profile of 13 Largest Customers 24

Figure

- Figure 1. A Scheme of Customer Classification 29

Introduction

In recent years, marketing practitioners as well as academicians have emphasized the importance of building relationships with customers, embracing such concepts as one to one marketing, relationship marketing, targeted marketing, and interactive marketing. The premise behind these concepts is that one can address and target individual customers and thereby improve the firm's profitability by serving customers differently. This has given new meaning to the age-old marketing concept of being customer driven. As the ability to collect customer level information increases and the cost of collecting and processing such information falls, more and more firms are becoming customer driven. However, to be customer driven under this new paradigm, firms will increasingly need to develop the capability to evaluate profitability at the customer level to better formulate marketing strategies. Blattberg and Deighton (1996), for example, suggest that firms should focus on building and managing customer equity and not just brand equity. Customer equity is the sum of customer lifetime values (LTV) where each customer lifetime value is the sum of stream of net profits, properly discounted, from the customer over the lifetime of that customer with the firm. When each customer's LTV can be computed, interesting possibilities open up. The firm can identify their best prospects and target the most profitable ones differently from the less profitable ones. Promotional and other strategies aimed at customer acquisition or retention can be evaluated based on which strategy yields the richest pool of customers with high potential LTVs. In order to compute a customer's LTV, models and measurements must be designed to compute the profitability at the customer level. In this paper we develop a customer profitability model within a supply chain, using a large wholesaler/distributor as the empirical setting.

For the purpose of modeling as well as gathering data, we focused on a wholesaler/distributor that buys from several suppliers and resells to hundreds of retailers (customers). However, the firm's customers do not require different services provided by the distributor in equal proportions or in any fixed proportion to quantity ordered. The distributor, in turn, does not calculate profitability (net of service costs) at the individual customer level and, therefore, does not know the nature or magnitude of variations in the costs of servicing its customers. Consequently, the distributor did not know that many of its customers are barely profitable or, worse, unprofitable. In addition, some of the distributor's biggest customers were in the process of adopting some of the recommendations of the food industry's Efficient Consumer Response (ECR) initiatives (Kurt Salmon Associates 1993), which would considerably change the service demands they made on the distributor's system. The desire to understand the cost of doing business in the face of shifting customer characteristics motivated the distributor to share data for this research.

In order to understand the costs associated with each customer, we build an elaborate cost model by carefully examining the details of the transactions in the supply chain. Using activity-based costing (ABC) analysis (See Kaplan and Cooper [1997] for a survey of development of the methodology), we estimate costs and identify

cost drivers[1] for different activities that go into these transactions. We then combine a general revenue model with the cost model to arrive at a profitability model at the individual customer level. In order to focus ourselves exclusively on service costs in the context of heterogeneous customers, we do not analyze competitors or some other demand-side factors.

Not surprisingly, we find evidence that all customer dollars are not equal in their effect on the firm's net profits. While volume remains a very important indicator of profitability, customer service costs play an equally important role in determining which customer is profitable and which is not. In fact, we find that a large number of customers (32 percent of total) in our data are unprofitable, including some of the largest customers. Finally, we also find that new practices like ECR could affect the total service costs and its distribution to various channel members in such a way that more customers may become unprofitable.

Our contributions to the marketing literature are the following. We integrate the customer profitability literature in marketing with the latest developments in management accounting and develop a conceptual profitability model that includes a carefully developed cost model using ABC analysis. Second, we present a detailed blueprint of actual implementation of customer profitability analysis in a very important industry that could work in a variety of business-to-business situations. Third, we provide evidence of relationships between customer transaction characteristics and revenue, service cost components, and measures of profitability. Finally, we provide an alternative framework to evaluate marketing programs and internal incentive structure. The framework can generate tools that can be used to influence internal (for example, salesforce or capacity planning) or external, i.e., customer, behavior towards more profits.

The rest of the paper is developed as follows. The next section further motivates our paper in the context of the relevant literature. Since the topic of customer profitability in a supply chain context is of interest to the fields of marketing as well as management accounting, we briefly touch upon research from both fields. We then describe interactions in multi-echelon supply chains and present a detailed conceptual model of customer profitability as well as provide theoretical discussions of some important factors that affect customer profitability. We then present the research site and illustrate the process of implementing the conceptual model. Finally, we present our analysis of the factors affecting customer profitability and empirical testing of the relationships posited earlier, and conclude with implications and a brief discussion of the limitations of this study.

Background

The theoretical foundation for target marketing and one-to-one marketing can be found in the microeconomic theory of price discrimination which states that if different customers have different elasticities to different marketing mix variables, then a targeted or tailormade strategy would be optimal. While conceptually sound, this theory does not take into account the differential costs of serving different customers nor does it provide a model or measurement tools. Thus, in developing a customer-focused strategy, it is important to recognize that customers are heterogeneous in their purchase behavior and in their sensitivity to marketing mix. This heterogeneity in turn induces heterogeneity in the cost of servicing them. In order to make the right selection of customers, models and measurements should be designed to identify and allocate all the different costs related to customers based on their interactions with the firm.

A number of authors have advanced conceptual frameworks and have argued why targeted marketing or marketing different programs to different customers is a winning strategy. Popular books by Peppers and Rogers (1993) on one-to-one marketing, and Hallberg (1995) on customer heterogeneity are prime examples. Jackson (1985) also argues that customers with certain characteristics might not be financially attractive enough for a firm to warrant maintaining or even initiating long-term relationships. All these assertions assume that firms can develop measures of the economic worth or LTV of customers. This involves three interrelated tasks. First, one needs to know how to calculate the current profits for each customer. Second, one needs to ascertain or estimate customers' lifetime duration, and finally, one needs to project net profits from each customer over his or her lifetime. Our focus in this paper is on the first step of ascertaining the current profitability of customers. This step requires understanding the various components of revenue and cost streams as they relate to individual customers.

In many analyses of LTV, the measurement of customers' current profits is often incomplete or assumed away as being proportional to sales volume or revenue. In a typical business involving multiple suppliers and numerous customers such as a large wholesaler/distributor, there are several types of costs incurred in developing and maintaining relationships with customers. Not all costs are proportional to sales volume or revenue. Some costs vary with transactions, others with a batch of transactions, yet others with the number of customers or lines of businesses, and so on. In their interactions with a business, customers also vary, often by several orders of magnitude, along many dimensions: volume, frequency and/or size of order, need for service, payment habits, and the like. These dimensions of customer characteristics often interact with different types of costs, further violating the assumption of proportionality of customer service costs to sales volume or revenue. For example, two customers who buy 1,000 units of similar products in a year at virtually identical prices or margins may appear to be equally profitable for the seller. However, it is likely that the customer who buys 5 units each of 10 different items (SKU) 20 times in the year is more costly to service, and hence less

profitable for the seller than, say, another customer that buys 1,000 units of a single item in a single purchase. Thus, customers with widely different interaction characteristics impose different kinds of transaction-related cost burdens on the seller and it is necessary to go into the details of these to ascertain the value or profitability of a customer. Current accounting information systems tend to ignore this. It is for this reason that practitioners' journals for businesses as diverse as banking (Kerr 1998), high tech (Hoffman1998), and database marketing (Post 1997) report the failure of firms in their industries to measure product and customer profitability by their existing systems.

The issue of customer profitability has also been of growing interest to the management accounting literature (Shields 1997). With the advent of activity-based costing, management accounting researchers have focused on understanding the factors that drive customer service costs and profitability in order to use this information for better management and control of customer services and related operations. More recently, customer profitability measures are used to investigate the impact of customer-focused nonfinancial performance measures (such as customer satisfaction) on financial performance measures such as profits and firm value (Foster and Gupta 1998; Ittner and Larcker 1998).

In marketing literature, Berger and Nasr (1998) advance a series of models, along with numerical examples, illustrating how to compute LTV in some "typical" situations. They, however, do not provide any empirical application of their models of customer profitability. Also, they do not fully consider consumer heterogeneity on several dimensions. Using data from the pharmaceuticals industry, Mulhern (1999) provides an application for evaluating customer profitability and computing LTV. The seller in his application is the pharmaceutical company and prescribing physicians and specialists are the customers. Our work, though similar in spirit, is different than his in certain important ways, primarily in the details of revenue and costs. On the revenue side, Mulhern has a simple model since the implicit assumption is that of constant gross margins. Moreover, because of the nature of interactions between "seller" and "customers" in his model, the only costs he considers are salespersons' time, free samples, and direct mail expenditure. Thus, one might describe this as an analysis of the differential impact of advertising and sales promotion effort on different customers rather than a full-fledged customer profitability analysis. In addition, the industry Mulhern analyzes is very specialized, whereas we provide an empirical analysis for a fairly general business-to-business situation, in which direct buying and selling transactions take place between the buyer and seller. Finally, his main focus was on showing heterogeneity in effectiveness of marketing program (which he calls concentration), whereas we also provide empirical links between customer characteristics and profitability.

Forecasting the revenue and cost streams for customers' lifetime duration[2] is very difficult if revenue or cost components are not correctly identified or cannot even be measured at their current levels. Also, different revenue and cost elements can be affected differently by the actions taken by the firm (adoption of efficient technology, targeted advertising, and promotional policies, etc.). We believe that carefully identifying and quantifying the components of the revenues and costs will also result in better forecasting of these elements over the lifetime of customers.

In sum, the issue of determining customer profits requires a much more careful treatment of revenue as well as costs associated with individual customers than has typically been addressed in the literature. To this end, we build a more elaborate cost model, taking into account various different components of costs associated with individual customers to arrive at a much more accurate customer profitability measure. Our revenue model explicitly allows for different margins and discounts across products and customers. In addition, we also explore relationships between customer characteristics and various measures of profits and costs. This potentially provides us with a tool to assess the desirability of certain specific marketing actions. Thus, relative to the extant literature in marketing, we not only develop a customer profitability model for a large wholesaler/distributor but also empirically investigate the linkage between customer profit and several customer purchase characteristics and advance implications of these relationships.

Customer Profitability Model

The Supply Chain

While our modeling as well as empirical focus will be on a wholesaler/distributor, we first briefly describe the interactions between various levels of the supply chain in order to understand the activities and costs arising in the entire channel. In the next subsection, we develop a cost model for the distributor, and identify activities and cost drivers to allocate the distributor's cost among its customers (retailers). Throughout the rest of the paper, we refer to these retailers as customers and the end-consumers as consumers. Along with a general model of revenue from customers, this cost allocation model enables us to evaluate profitability at the customer level.

We consider a three-layered supply chain (manufacturer - wholesaler - retailer) starting with the manufacturer who normally sells only to the distributor but sometimes makes direct delivery for large orders to retailers on behalf of the distributor. This practice is sometimes called "drop shipment" in this business. A drop shipment occurs in our supply chain when an item is delivered directly by the manufacturer to a retailer's warehouse, bypassing the "normal" process of going through the distributor's warehouse. Typically, only large retail customers with a distribution center are able to avail themselves of drop shipment. The next layer is the wholesaler/distributor who buys from the manufacturer and sells to the retailers. Its customers include some individual retail stores and some retail distribution centers (RDC) of the larger retail chains. These retailers represent the third layer of the supply chain who sell to the ultimate consumers of the products. Large retail chains usually maintain RDCs but recently, especially with the adoption of efficient replenishment recommendations of ECR, they are also adopting direct store delivery for many products.

We conceptualize the total supply chain interaction as consisting of two primary processes corresponding to the flow of orders (ordering process) and the flow of physical goods to fulfill these orders (fulfillment process). The ordering process in the supply chain starts at the retailers' end as they deplete the stocks by selling to consumers. Individual stores indicate their demand to the respective RDCs (if applicable), who in turn consolidate the demand from individual stores and pass it on to the distributor. The distributor consolidates the demand from its customers in its purchases from manufacturers. The fulfillment process virtually mirrors the ordering process except as mentioned earlier in the case of drop shipments. The two processes are summarized in Table 1. To support the transactions listed in Table 1, inventory needs to be carried at the retailers' as well as distributor's warehouse. Also, accounting and administrative services like those associated with vendor selections, selling, and routine customer maintenance, as well as matching physical flows with account books, are needed. Additional details of these support services are provided in the appendix.

Table 1. Activities in the Supply Chain

ORDERING PROCESS

	Activity	Type	Addressed to	Action by the Addressee	Frequency per Period
O1	Stores raise purchase orders	—	RDC	Order receiving and consolidation	k_i times for each store
O2	RDCs raise purchase orders	—	Distributor	Order receiving and consolidation	k_i times for each RDC
O3a	Distributor raises purchase orders	Normal	Manufacturer	Order receiving and proceed to fill	k times for each manufacturer
O3b	__ ,, __	Drop	__ ,, __	__ ,, __	k_i times for each supplier-retailer pair involved in drop shipment

FULFILLMENT PROCESS

	Activity	Type	Addressed to	Action by the Addressee	Frequency per Period
F1a	Manufacturer fills orders	Normal	Distributor	Receiving, material handling, inventory, accounts payable	k times for each manufacturer
F1b	__ ,, __	Drop	-RDC -Distributor	-Receiving, material handling, inventory -Accounts payable	k_i times for each supplier-retailer pair involved in drop shipment
F2	Distributor fills orders	Normal	RDC	Receiving, material handling, inventory, accounts payable	k_i times for each retail customer
F3	RDC fills orders to affiliated retail stores	—	Retail stores	Receiving, material handling	k_i times for each of the N_i affiliated stores

Note: See appendix for notations used in the last column of tables 1 and 2.

Customer Profitability for the Distributor

In order to ascertain profitability at customer level, revenue and costs attributable to individual customers need to be identified. Total revenue from customer *i* for a period is given by:[3]

$$\sum_{s \in S_{iT}} \text{(Price Charged to Customer } i \text{ for item } s) * \text{(Total Quantity of } s \text{ purchased by } i \quad (1)$$

In the most general formulation for revenue, prices for the same item are allowed to differ across customers. The first, and usually the biggest, cost item in transactions involving buying and selling physical goods is the purchase price or cost of the goods sold (COGS), and is given by

$$\sum_{s \in S_{iT}} \text{(Cost of item } s) * \text{(Total Quantity of item } s \text{ sold to customer } i \quad (2)$$

Notice that since the distributor buys for several customers, the unit cost of item *s* will differ across items but not across customers.

Expression 1 minus 2 is the gross profit for the distributor from customer *i.* Most of the analytical work in marketing assumes that the net profit from customers has a perfect correlation with gross profits. However, we maintain that the assumption of net profits being proportional to the gross profits may not be correct in most industries, primarily because different customers require different levels of services and hence impose different costs that may not be proportional to revenues or gross profits. One useful way of thinking about the elements of service cost is as a hierarchy, roughly in decreasing degree of variability with units. Some cost elements vary by units, which could be dollars (e.g., inventory holding cost) or physical units (e.g., physical handling costs). Some others are batch or transaction level costs (e.g., order processing cost) and vary by number of underlying transactions irrespective of how many units are involved. Yet others are transaction partner level costs. Some examples of these are costs of maintaining a vendor or customer on account books and cost of some minimal level of contact time with them. Finally, there are enterprise level costs. These relate to maintaining the facility (like warehouse space costs) and the like.

We present the cost components that make up these other costs and identify the portion attributable to a customer in Table 2. In identifying the cost components, we follow the sequence and numbering as in Table 1, to the extent applicable. The total cost allocated to customer also includes those incurred for the support activities mentioned earlier. These include the cost of maintaining vendors and customers and the inventory carrying costs. In terms of cost hierarchy presented above, many of these support costs are the transaction partner level and enterprise level costs, whereas activities in the ordering and fulfillment processes usually generate unit or transaction level costs. Another significant portion of total cost of the distributor is what can roughly be called selling and routine customer maintenance cost. Usually, and in our empirical context, this is primarily the cost of maintaining a salesforce, promotional mailings, free samples, etc.

Table 2. Distributor's Activities, Related Costs, and Allocation of Costs to Individual Customers

	Base Activity	Distributor's Action and Cost Rate ($)	Cost Rate Includes	Share of Distributor's Service Cost Attributable to Customer *i*
ORDERING PROCESS				
O2	RDCs raise purchase orders	Order receiving—OR	Order receiving, A/c receivable	$OR^{*} k_i$
O3a	Distributor raises purchase orders (normal)	Order issuing—OI	Order issuing, A/c payable	$OI{*}k\sum_{s:s\in S_{iN}} \frac{m_{is}{}^{*}N_i}{\sum_{i=1}^{I} m_{is}{}^{*}N_i}$
O3b	Drop shipment purchase orders	Order issuing—OI	Order issuing, A/c payable	$OI{*}\sum_{s:s\in S_{iD}} k_i$
FULFILLMENT PROCESS				
F1a	Manufacturer fills orders (normal)	Batch level inbound handling—HA_1	Locating PO, scanning, checking for accuracy	$HA_1{}^{*}k\sum_{s:s\in S_{iN}} \frac{m_{is}{}^{*}N_i}{\sum_{i=1}^{I} m_{is}{}^{*}N_i}$
		Unit level handling—HA_2	Physically unloading and stocking	$HA_2{}^{*}\sum_{s:s\in SiN} m_{is}{}^{*}N_i$
F1b	Drop shipments	—	—	No cost to distributor
F2	Distributor fills orders	Batch level outbound handling—HA_1	Locating PO, scanning, checking for accuracy	$HA_1{}^{*}K_i$
		Unit level handling—HA_2	Physically moving and loading	$HA_2{}^{*}\sum_{s:s\in SiN} m_{is}{}^{*}N_i$
SUPPORT SERVICES				
S1	Inventory carrying at the distributor's store	Stocking and holding—ST & HO	Space cost, store maintenance, and capital cost	$ST^{*}\sum_{s:s\in SiN} Vol_S\,\beta_s{*}m_{is}{*}N_i$ $+HO^{*}\sum_{s:s\in SiN} C_S\,\beta_s{*}m_{is}{*}N_i$
S2	Vendor maintenance	Keeping vendor active—VM	Accounting, minimum contacts	$VM^{*}\sum_{s:s\in S_{iT}} \frac{m_{is}{}^{*}N_i}{\sum_{i=1}^{I} m_{is}{}^{*}N_i}$
S3	Selling and routine customer maintenance	Sales calls to customers—SF_i	Accounting, maintaining appropriate contacts with customer	$SF_1{}^{*}m_i + SF_2{}^{*}k_i + SF_3{}^{*}s_{iT}$ $+SF_4{}^{*}\sum_{s:s\in S_{iT}} P_{is}{*}m_{is}{*}N_i$

(1) $\sum_{s:s\in S_{iT}} P_{is}{*}m_{is}{*}N_i$

(2) $\sum_{s:s\in S_{iT}} C_s{*}m_{is}{*}N_i$

(3) $OR*k_i + OI*k\sum_{s:s\in S_{iN}} \frac{m_{is}{}^{*}N_i}{\sum_{i=1}^{I} m_{is}{}^{*}N_i} + OI*\sum_{s:s\in SiD} k_i + HA_1*k\sum_{s:s\in S_{iN}} \frac{m_{is}{}^{*}N_i}{\sum_{i=1}^{I} m_{is}{}^{*}N_i} + HA_2*\sum_{s:s\in SiN} m_{is}*N_i + HA_1*K_i + HA_2*\sum_{s:s\in SiN} m_{is}*N_i\,ST*\sum_{s:s\in SiN} Vol_S\,\beta_s*$ $m_{is}*N_i + HO*\sum_{s:s\in SiN} C_S\beta_s*m_{is}*N_i + VM*\sum_{s:s\in S_{iN}} \frac{m_{is}{}^{*}N_i}{\sum_{i=1}^{I} m_{is}{}^{*}N_i} + SF_1*m_i + SF_2*k_i + SF_3*_{SiT} + SF_4*\sum_{s:s\in SiT} P_{is}*m_{is}*N_i$

Taking all the cost components together, the total service cost for customer *i* is given by:[4]

Order Receiving Costs (O2) + Normal Order Issuing Costs (O3a) + Drop Order Issuing Costs (O3b) + Inbound Handling Costs (F1a) + Outbound Handling Costs (F2) + Inventory Carrying Costs (S1) + Vendor Maintenance Costs (S2) + Selling and Routine Customer Maintenance (S3) *(3)*

The last column of Table 2 presents the formal expression for customer *i*'s share of distributor's service costs using the notations detailed in the appendix. Formal expressions of expressions 1, 2, and 3 are also given at the bottom of this table. It is clear from the formal expression for Expression 3 that service costs differ across customers in a complicated manner depending upon their characteristics, such as order frequency, number of items, volume, and degree of customization of purchase mix, etc. In general, the costs will neither be the same across customers nor be just proportional to units sold or sales revenue. Given the above cost and revenue model, net customer profits can be arrived at as Expression 1 minus Expression 2 minus Expression 3. If a profitability rate is considered appropriate then per-unit or per-dollar profitability can be arrived at by dividing the total profit expression with the total units bought by the customer or the total revenue from the customer. The point is, whatever way we look at customer profitability, it remains a function of various dimensions of customer characteristics and not just volume. To summarize:

Customer Profitability = f (Total Revenue, Sales Price Premium/Discount, COGS, Customer Service Costs), where

Customer Service Costs = f (customer characteristics like size, order frequency, proportion of drop shipments, number of items, number of shipping locations, degree of customization of product mix)

Price Premiums/Discounts and Effective Margins

Recall that our revenue model allows for different prices (P_{is}) being charged for the same item to different customers. Let P_s be the standard price of the item *s*, then the difference $|P_s - P_{is}|$ is the price discount or premium for customer *I* as the case may be. While there may be some legal issues involved in adopting this practice,[5] a seller might try to compensate for high service costs imposed by certain customers by charging a higher price to them or equivalently, providing some kind of discount to other customers. It is possible that managers would intuitively try to arrive at a discounting scheme that adjusts for service costs but several counterbalancing factors may lead to the absence of this relationship in real data. First, as stated earlier, managers may not correctly know the costs associated with servicing a customer. Also, if salespeople are given some pricing discretion and their incentives are not properly set, taking the service costs into account, they may make suboptimal pricing decisions. Then there is the practice of offering volume-based discount (implicitly advocated by literature treating costs other than COGS as fixed). Finally, discounts may be offered due to competitive reasons or long-term growth prospects, etc. We explore some of these issues in the empirical analysis section.

Tradeoffs and Interaction among Customer Characteristics

In the sense of partial or *ceteris paribus* effects, each parameter of the cost element has a very clear impact on cost and profitability. However, profitability may be seen as being determined as an interaction of margin, volume, complexity, and efficiency factors associated with customers. We discussed effective margins previously. Volume is associated with spreading out of transaction and transaction partner level costs to more units. Therefore, it is likely to have a positive association with total service costs but negative association with service cost margins. Complexity refers to customer characteristics that need more effort, like number of orders, number of items, number of shipping locations, etc., while efficiency refers to factors that might lead to cost savings, like proportion of drop orders. This implies that higher complexity should be associated with higher service costs and lower profitability whereas higher efficiency should be associated with lower costs and higher profits. There are possible interactions between customer characteristics, volume, and effective margins that influence customer profitability. We mention some of the more likely interactions and associations below and we further investigate them in the empirical analysis section:

- *Margin–Volume:* Volume-based discounts are fairly common in this industry, as well as in many others, and it would be interesting to see if volume alone justifies the lower margins. Another interesting related issue would be to explore how successful managers are in linking discounts to service costs.

- *Margin–Volume–Efficiency:* A higher proportion of drop shipment units provides efficiency. On the other hand, it might interact with margins in the sense that high drop shipment customers are also large customers who may be given higher discounts (lower margins), offsetting efficiency gains.

- *Margin–Volume–Complexity:* Orders for special items, which represent the degree of customization of product mix, provide an interaction of these three factors. It is possible that only high volume customers give orders for special items, thereby reducing the importance of special order costs. However, since truly special orders are ordered just for a customer, they can be easily priced to reflect these costs. Therefore, it is possible that special orders have a positive association with costs but no impact on profitability.

- *Volume–Complexity:* High order frequency clearly increases the complexity of customer-related transactions, so it should be associated with low profitability and higher customer costs. However, it may be associated with higher volume acting as a counterbalancing factor. Similarly, a higher number of shipping locations for a customer is a proxy for need for higher contact time with the customer. Therefore, it is a complexity-enhancing factor. On the other hand, only relatively larger customers are likely to have multiple shipping locations, mitigating the strength of this relationship.

- *Interaction among Complexity Factors:* A large number of different items should be positively associated with the costs since the customer needs to take the burden of sharing a larger fixed cost of maintaining vendors and inventory, etc. However, this variable probably interacts with the propor-

tion of special items variable. A customer with a large number of items, most of which are also bought by a large number of other customers, ends up sharing a smaller amount on this account than another customer who has relatively fewer items but most of them are special order items, i.e., ordered by one or very few customers. The possibility of larger customers being associated with a large number of items may affect the strength of this relationship also.

After conceptually presenting the customer-specific revenues and costs, we now turn to a description of our research site and describe our approach that can serve as a blueprint for empirically estimating customer profitability in similar supply chains.

Data and Implementation of Customer Profitability Model

The data for our empirical study were made available by a wholesaler/distributor selling to grocery and other retail businesses (name withheld for confidentiality). The data pertain to one of its regional warehouse operations in the U.S. Our research site warehouse serves more than 650 customers of various sizes scattered throughout a multi-state region surrounding the warehouse. A significant portion of packaged goods and other consumer products pass through specialized distributors and we believe that our description of the supply chain interactions here, although primarily based on the study of operations of one distributor, is representative of the supply chain interactions of such industries.

We had access to transaction level data for a period of one year that details the firm's purchasing, selling, and warehousing activities. A major complementary source of data was the company's internal budget documents and interviews with relevant managers to obtain projected breakdown of costs for various activities. Information from these sources was used to identify costs to be allocated to each individual customer. These costs include vendor maintenance, order placement, shipment receiving, and inbound physical handling, constituting the costs related to the purchase end of the business. Cost of receiving orders from customers, customer service and dispute resolution, salesmen cost, and outbound physical handling of goods being sold, etc., relate to the sales end of the business. Finally, there are costs related to activities like warehousing and inventory carrying that mediate the two ends of the business.[6]

The overall costs of relevant activities or cost pools were obtained from the company's internal documents and discussions with managers while the customer-specific activity information was obtained from data files detailing the firm's purchase and sales activities. Costs incurred at the sales end of the business can be easily identified with specific customers. However, costs of purchasing and warehousing of the items were first allocated to the items (by preparing appropriate per-activity rates) per unit and then transferred to the purchasers of those items.

Next, we present the descriptive profile of the customer base in Table 3. In panel A of the table, we present the mean, median, and range for some important characteristics. We can see tremendous heterogeneity on many of the variables. In terms of the revenue and pricing information, the information we had access to was aggregated to the customer level (e.g., individual SKU level prices were not available to us). The net purchase cost for items purchased by customers as well as discounts, if any, were also made available to us. This enabled us to calculate gross margins for each customer. Panel B of Table 3 provides distribution of a revenue dollar in various cost and profitability measures. Besides the distribution for the entire customer base, distribution for two median customers (customers ranked 329 and 330 on sales revenue) are also presented. The dramatically different cost

and margin numbers for these two essentially similar-sized customers highlight the importance of not relying solely on sales revenue. We also point out that as a percentage of total sales, discounts equal about 4.1 percent, purchase and warehousing costs about 2.5 percent, order fulfillment and services costs 2.1 percent, and customer maintenance and selling costs 2.4 percent. Individually and taken together, these costs are very substantial, relative to the net profit margin of about 8 percent.

Table 3. Profile of Customers (total 658 customers)

PANEL A. ACTIVITY PROFILE

Item	Number of Customers (for item > 0)	Mean	Median	Range Min - Max
1	2	3	4	5
1. Number of Orders Placed	658	683.1	17.0	1.0 - 107158.0
2. Total Units Purchased	658	5990.4	147.5	1.0 - 757252.0
3. Drop Shipments as % of Total Units	130	24.5	7.9	.0 - 100.0
4. Discount %	72	4.96	5.00	.0 - 10.2
5. Number of Different Items Ordered	658	49.0	8.0	1.0 - 1652.0
6. Number of Units per Order	658	47.9	5.2	0.75 - 21373.0
7. Dollar Value per Order	658	249.8	97.6	2.46 - 7945.2
8. Special Item Units as % of Total	359	24.4	8.0	.02 - 100.0
9. Number of Different Shipping locations	658	6.3	1.0	1.0 - 374.0

PANEL B. PROFITABILITY PROFILE

Item	All Customers (%)	Median Customer 1 (%)	Median Customer 2 (%)	Range Min - Max (%)
1	2	3	4	5
1. Invoice Sales	100.0	100.0	100.0	100.0 - 100.0
2. Cost of Goods Sold	80.68	67.09	81.86	26.17 - 97.65
3. Explicit Discount	4.14	.0	.0	.0 - 10.26
4. Gross Profit: After Discount (1-2-3)	15.18	32.91	18.14	2.35 - 73.83
5. Purchase and Warehousing Cost	2.51	2.74	4.68	.56 - 241.16
6. Order Fulfillment & Services Cost	2.15	.70	3.91	.31 - 89.20
7. Selling and Routine Customer Maintenance	2.42	3.48	3.62	1.77 - 235.21
8. Total Service Cost (5+6+7)	7.01	6.82	12.12	3.57 - 304.44
9. Net Customer Profits (4-8)	8.16	26.09	6.02	-249.71 - 64.10

Empirical Analysis of Factors Affecting Customer Profitability

Distribution

We start our analysis with a look at the distribution of profits among customers. At the top end, we find that as much as 79 percent of revenues and 78 percent of net profits come from the top 13 customers who have invoice sales in excess of a million dollars each. While this is the famous 80-20 rule in an extreme form (Schmittlein, Cooper, and Morrison 1993), this clearly makes the distributor excessively vulnerable to changes in the business practices of these big customers. At the opposite end, as many as 212 (32 percent of total) customers are unprofitable if costs of all the activities they cause are imposed on them. However, as mentioned before, we need to go beyond merely showing concentration in distribution of profitability. In fact, although there are unprofitable customers at all levels of revenue, about three-quarters of these unprofitable customers are relatively small, having sales of less than a thousand dollars each. Clearly volume matters, but we go on to explore to what extent volume *alone* matters.

Before proceeding with any analysis of factors affecting customer profitability, we divide the customers in three groups. At the lower end, we have about 82 customers with annual revenue less than one hundred dollars each.[7] These are mostly occasional customers who walk up to the warehouse and pay cash for delivery on the spot. As a group, they account for less than .01 percent of sales revenue, customer costs, and profits. These are insignificant and atypical customers and hence we will not include these in further analysis. At the top end, there are 13 customers each with revenue in excess of one million dollars. These customers are so big that they are mostly statistical outliers and will be too influential in calculating any statistics. Interestingly, these customers vary widely in net profitability and not all of them are profitable. We first report statistical analysis for the group of 563 customers that remain after deleting the two extremes. However, we come back to the 13 large customers later since they provide very clear illustrations of some of the typical issues.

Portfolio Analysis of Customers

First we divide these customers into 10 nearly equal-sized portfolios by grouping customers in decreasing order of sales revenue; some statistics by portfolio are presented in Table 4. The second column provides total revenue for the group of customers included in the portfolio. The rest of the table presents the gross profit margin, service cost as percent of sales, and net profit margin for these portfolios in two different ways. Portfolio means for these three variables are presented first, followed by the ranges of these variables within the portfolio.

It is notable that while the average effective gross margins monotonically increase as we go down to the portfolio of smaller customers, the service cost also increases almost in parallel and as a result, net margins fail to show a clear trend. That is, the

service costs monotonically increase for smaller customers. This is primarily the volume effect: as the total units come down, the importance of transaction level and transaction partner level costs goes up, making the relative costs at the customer level higher and higher. Clearly management recognizes this and attempts to recover higher margins from smaller customers. While they more or less succeed in protecting the margins across groups of customers on an average, the existence of more than 125 unprofitable customers among these 563 indicates that they do not have an accurate assessment of the nature or magnitude of costs associated with individual activities. In the absence of any market power, the small customers are nearly price takers, and typically in this situation, a high profit margin net of service costs could be expected from these customers. It turns out that even though management is intuitively aware of the high service costs of these customers, management nevertheless underestimates the cost and fails to take full advantage of its own market power. The range statistics for the portfolios also highlight the presence of unprofitable customers at all levels.

Table 4. Size Portfolio of Customers' Mean Values and Ranges (ranked by sales revenues)

Group Number	Share of Total Sales (%)	Gross Profitability Margin	Service Cost as % of Sales	Net Profit Margin	Gross Margin Range	Service Cost Range	Net Margin Range
1	13.86	17.48	9.66	7.82	5.11 - 33.32	4.71 - 25.61	-2.10 - 26.38
2	3.43	20.80	11.96	8.83	9.00 - 54.07	3.57 - 33.70	-9.58 - 50.50
3	1.72	20.23	13.39	6.84	11.44 - 68.93	4.83 - 53.39	-24.11 - 64.10
4	.88	21.35	15.27	6.08	2.36 - 46.08	4.41 - 71.71	-53.63 - 33.49
5	.47	25.25	16.08	9.17	9.97 - 52.32	5.23 - 78.91	-42.56 - 39.03
6	.23	25.33	15.77	9.55	2.35 - 61.20	5.04 - 51.42	-31.49 - 53.09
7	.13	29.45	17.49	11.96	10.00 - 62.15	7.69 - 52.33	-30.39 - 54.46
8	.06	31.63	29.49	2.14	3.55 - 70.14	9.95 - 264.74	-243.58 - 58.96
9	.02	38.80	36.90	1.90	11.52 - 68.12	16.71 - 111.64	-79.43 - 46.90
10	.01	40.41	60.67	-20.26	5.53 - 71.05	28.96 - 192.95	-161.07 - 39.35

Price Premiums/Discounts and Effective Margin

We now turn to the analysis of discounts given to customers. It is a significant factor in understanding customer profitability and may be an effective tool to manage or counterbalance customer costs. In the absence of any direct data on these discounts or a standard list price, we need to infer the level of discount from the gross margin data. This requires additional assumptions about similar product mix across customers and/or similar margins across products. We argue that, because the products the distributor deals in are usually very standardized and not very differentiated and because the customers are primarily in very similar businesses, it is very unlikely that either margins or the product mix varied substantially.

Therefore, we define total discounts as the difference between the average gross margin for the entire customer base and the gross margin for the customer. In correlation analysis, we find that total discount is positively related to sales revenue ($p = .23$) and negatively related ($p = -.29$) to service costs. This means that volume-based discounts were probably offered but also that, for this sample, large customers were also associated with relatively lower service costs. The net effect of these two factors still shows up as a negative correlation coefficient ($p = -.34$), indicating that customers that started with high gross margins (low discounts) ended with higher net margins, so differentials in service costs were not completely offset by gross margin differentials.

Correlation and Regression Analyses

We now present some evidence of statistical association between cost and profitability measures and customer characteristics. Customer size is a well-recognized and important factor in determining profitability so we first see how it is related to the customer characteristics. The results of a multiple regression of total units on customer characteristics are presented in panel A of Table 5. The reported significance levels have been derived using White's consistent covariance estimates since large heterogeneity in the size of customers gives rise to concerns for heteroskedasticity. Here we find that the cost activity drivers like number of orders and number of different items are also positive business drivers, i.e., these are also associated with higher quantities. We also find that drop shipment units and special item units are both more likely for larger customers but the second association is not statistically significant. Larger customers are also found more likely to have larger dollar order values, but a significant negative association of quantity with units per order probably just reflects a partial effect after accounting for other variables in the model, especially number of orders.

Table 5. Correlation and Regression Analysis (number of observations = 563)

	Number of Orders	Number of Shipping Locations	Drop Shipments Units	Number of Different Items Ordered	Special Item Units	Number of Units per Order
Panel A. Regression Results: Customer Size						
Quantity	8.35[a]	-43.54	1.20[a]	19.16[a]	.11	-.61[a]
(Adjusted R^2 = .72)	(3.23)*	(28.33)	(.03)	(6.83)	(.11)	(.19)
Panel B. Partial Correlation Coefficients (Pearson / Spearman)						
Gross Profit	.42[a] / .14[a]	.52[a] / .24[a]	.07[c] / .09[b]	.33[a] / .17[a]	.26[a] / .03	.01 / -.09[b]
Total Service Cost	.84[a] / .64[a]	.51[a] / .29[a]	-.17[a] / .23[a]	.67[a] / .61[a]	.06 / .36	.08[b] / -.37[a]
Net Customer Profit	-.12[a] / -.22[a]	.20[a] / .05	.19[a] / -.14	-.09[b] / -.20[a]	.22[a] / -.18[a]	-.04 / .10[a]
Panel C. Regression Results: Customer Profitability						
Gross Profit	.35	25.83[a]	.53	.76	-.66	.32[a]
(Adjusted R^2 = .24)	(.89)	(8.08)	(.48)	(1.24)	(.48)	(.08)
Total Service Cost	7.63[a]	35.03[a]	-2.48[a]	.13	2.51[a]	.28[a]
(Adjusted R^2 = .66)	(.94)	(8.51)	(.50)	(1.30)	(.50)	(.08)
Net Customer Profit	-7.27[a]	-9.2	3.00[a]	.62	-3.17[a]	.04
(Adjusted R^2 = .29)	(1.38)	(12.47)	(.74)	(1.91)	(.74)	(.12)

[abc] Respectively denote coefficients statistically significant at .01, .05, and .10 levels.

* Standard errors for the estimated regression parameters.

Next, we run regression of the following form:

$$\textit{Measure} = \beta_0 + \beta_1 * \text{Orders} + \beta_2 * \text{Shipping Locations} + \beta_3 * \text{Drop Shipment Units} + \beta_4 * \text{Number of Items} + \beta_5 * \text{Special Item Units} + \beta_6 * \text{Units per Order} + \beta_7 * \text{Sales Revenue};$$

where the lefthand-side variable is a measure of cost or profitability. We have included Sales Revenue in the regression in order to control for differences in sales volume. Before proceeding with more regression analysis, we point out two issues.

First, since customer characteristics are interrelated, the coefficients of multiple regression are like partial derivatives only and to assess the total impact of any factor, we need to get a total derivative-like measure which will also incorporate indirect effects through other variables. In order to give some flavor of the univariate relationship between cost and profitability measures and customer characteristics, we next present the results of partial correlation analysis[8] in panel B of Table 5, adopting a two-stage procedure partialing out the effect of size in the first stage.

Panel B of the table presents both Pearson and Spearman rank correlation coefficients. In most cases where the coefficients are significant, they are directionally similar to each other, which gives us some evidence that nonlinearity may not be a major problem here and we can perform parametric procedures with linearity assumption. The positive correlation of gross profits with number of orders, number of shipping locations, drop shipments, and number of items ordered probably indicates the nature of these characteristics as revenue drivers and/or their association with more attractive customers, in terms of either a profitable product mix or higher margin or both. Lack of significant correlation between gross profit and special items is somewhat unexpected since special items are probably provided to a customer with the expectation of a higher profit margin. Total service cost has expected relationships with all the complexity factors. Finally, net customer profit is negatively related with three complexity factors: number of orders, number of items, and number of special items. On balance, number of shipping locations does not have a significant relation with net customer profit, possibly because a higher gross margin just about covers the increased costs.

The second issue relates to heteroskedasticity in the presence of very large differences in volume. To correct the situation, we divide both sides of our regression equations by the Sales Revenue variable. This essentially converts the lefthand-side measures to respective margins. On the righthand side, we now have customer characteristics scaled by size. Since Sales Revenue is included in the regression only as a covariate, we do not report its coefficient. All other coefficients are reported in panel C of Table 5. Most customer services cost money, but they also attract customers and facilitate sales. Therefore, the issue in customer profitability management is not necessarily to cut down on customer service but rather to price it appropriately. We have seen that customer characteristics are both revenue drivers and cost drivers so the appropriate way to look at relationships is in a multivariate context and we turn to our regression results next. Our primary focus is on the customer profitability regression, but we also must pay attention to the coefficients in the customer service and gross profit regressions, since taken together they present a complete picture of the process of customer profitability.

We find that number of orders is positively related to gross profits (not significant) and service costs but on balance they lead to lower net profits, indicating that the cost effect dominates. Similarly, partial effect for shipping location is positive on both gross profits and cost but the net effect is negative although not statistically significant. Drop shipments have a positive impact on net profits, primarily driven by lower costs. Order size, represented by number of units per order, has no significant net impact on profitability though it has positive associations with both gross profits and service costs. Number of items fails to show any significant effect on cost or profit measures, probably because its impact is primarily indirect and hence does not show up in a partial setup. Finally, special item quantity has a negative coefficient for net profits, primarily driven by higher costs.

While one should be careful about interpreting the individual coefficients in a multiple regression, it seems that for our wholesaler/distributor, drop shipments are working out well while special orders and number of orders are money losers.

This could, for example, be due to salespeople's incentives on bringing orders where they pick up special orders at prices that do not fully reflect increased service costs. More generally, to the extent these results are representative of such supply chain situations, managers need to be careful about providing services and encouraging particular types of customer/salesperson behavior since some of them could be money-losing propositions in the absence of a good understanding of the benefits and costs of providing them. Similar conclusions come out of a descriptive analysis of the largest customers that we briefly present next.

Large Customers

As pointed out before also, this is a very important group of customers, accounting for 79 percent of total revenue and cost of goods sold, but only about 68 percent of customer service costs. The group also represents 91 percent of gross profit and 80 percent of net profits of the distributor.

Table 6. Profile of 13 Largest Customers

Customer Number	Share of Total Sales (%)	Gross Profit Margin	Service Cost as % of Sales	Net Profit Margin	Number of Orders	Drop Shipments as % of Total Units	Number of Shipping Locations	Number of Different Items	Number of Units per Order	Special Item Units as % of Total
1	2	3	4	5	6	7	8	9	10	11
1	19.1	11.3	4.0	7.4	16449	67.1	181	894	100.0	44.7
2	9.1	17.6	6.6	11.0	44760	43.7	647	1652	16.8	13.0
3	8.4	14.6	4.1	10.6	6019	57.4	4	344	81.4	39.6
4	7.8	13.7	5.0	8.8	12651	50.0	180	1012	51.3	37.2
5	6.1	17.1	5.3	11.8	8177	40.9	195	935	62.9	18.6
6	5.7	16.0	15.3	.7	107159	.0	275	547	4.2	1.6
7	5.6	13.4	5.2	8.2	11247	44.5	163	888	37.0	19.2
8	4.8	14.6	5.2	9.3	10179	53.8	67	713	43.5	31.6
9	4.7	17.8	8.2	9.7	53689	.4	134	567	8.0	10.7
10	2.8	10.0	4.6	5.5	3126	80.6	131	374	94.4	26.5
11	2.0	11.5	13.0	-1.5	41832	.0	29	420	4.1	2.5
12	1.6	13.1	5.3	7.9	5159	59.4	16	455	27.1	29.3
13	1.4	16.4	5.3	11.1	3655	41.5	3	380	32.8	16.1

Customers are ranked in decreasing order of sales revenue (column two) in Table 6. Only the percentage of total is reported for confidentiality reasons. The gross margin after discount (column three) varies between 10 and 17.8 percent. Column four represents the service cost as percentage of invoice dollars and shows remarkable variance between 4 and 15.3 percent. What is noteworthy is that the gross margin has no specific relation to either sales revenue or service costs. Neither cor-

relation coefficient is significant at any reasonable level, though we should interpret that with caution for such a small sample. Thus it is possible to have a large customer with low service costs and high gross margin, e.g., customer 3 or high service costs and low gross margin, e.g., customer 11. This tells us that whatever rule management is following for pricing does not reflect service costs imposed by these customers. We argue that this is partly because the management does not have knowledge of the exact magnitude of these service costs. Other reasons could include competitive and strategic factors or a short-term revenue focus of the salesforce that had some pricing discretion. To the extent that the pricing policy is distorted due to lack of understanding of cost, the need for understanding these costs more precisely is obvious. This point is reemphasized by the net margin (column five) that also shows a very wide range. The presence of an unprofitable customer among this elite group of customers is very surprising. A very high negative correlation, -.75, between service costs and net margins, that is significant at less than .01 level indicates that high service cost is an important reason for low profitability of customers in this sample.

The remaining columns of this table represent different important dimensions of customer characteristics. The tradeoff between margin, revenue, complexity, and efficiency factors can be readily illustrated here. Take customers 12 and 13, for example. They have very similar volumes, but quite different net margins. This is primarily due to different gross margins since they have similar complexity and efficiency factors leading to the same percentage of service costs. On the other hand, compared to 12, customer 11 has similar volume but very low efficiency (e.g., low drop shipments) and high complexity (e.g., number of orders). This, coupled with slightly lower gross margin to begin with, makes customer 11 unprofitable whereas customer 12 has a close-to-average net profit margin of around 8 percent.

In sum, this descriptive analysis confirms that large variations in customer profitability might exist at any level. Also, in many cases the existence of relatively unprofitable customers can be attributed to the high customer service costs that are not sufficiently reflected in the gross margins. Our discussions with company management revealed that the less profitable customers are mainly the ones that have recently shifted to ECR. Even though the management tried to mark their effective prices up by a constant percent at the time of the shift, because of differences in multiple characteristics, it was not able to reflect the true increase in cost in the prices it charged to some of them. One of these customers ended up being barely profitable and the other was actually unprofitable.

Conclusion

Implications

A major finding of this study is that all revenue dollars are not the same in terms of how much they affect the bottom line profit numbers. The differences across customers go beyond the volume of transactions alone. Managers should be aware of several other dimensions of customer differentiation. Our analysis points out that a substantial percentage of the firm's customers are unprofitable, a seemingly common problem (Hallberg 1995; Peppers and Rogers 1993). This observation points to two possible solutions. First, the firm can simply stop servicing all the unprofitable customers. It is sometimes argued that the cost of doing business with many of these "unprofitable" customers, specially the smaller ones, is not the full cost we arrive at using ABC analysis. These customers, so the argument goes, are being served by utilizing surplus capacity; as long as the sale price is higher than the purchase price, the firm is picking up some profit. While we agree that the solution may not be to stop serving these customers, we would suggest rethinking whether to serve them. If there is indeed surplus capacity for all the various activities, then perhaps profits can be increased more by shedding some of the surplus capacity than by using this surplus capacity to serve customers not justified by full costing. If there is capacity constraint, the issue of opportunity cost of serving more profitable customers arises. Also, at our empirical site as well as in many other facilities, there is often a temporary shortage of certain resources that leads to the creation of additional capacity which can be avoided by customer selectivity. This is especially true if these customers are considered as a group rather than individually. After all, over the long run, all costs are controllable and the analysis should prove a guide for determining what capacities to retain and what group of customers to focus attention on. Marketing strategy literature often suggests focusing attention on core customers, and making such fully informed decisions could free some valuable managerial time since small customers probably do take a disproportionate amount of managerial time.

The second solution is to adopt a practice of service-based or menu-based pricing, thereby changing the incentives and prices to the unprofitable customers so that they become profitable. In a survey of managers in the U.K., the most important use of customer profitability analysis was found to be as guidance for pricing policies (Innes and Mitchell 1995). Explicit discounts can be used as a tool to implement such pricing. Knowing the costs better may not be sufficient for a firm to adopt such a practice for strategic or competitive reasons. However, if practicable, such an analysis will give a better idea about what the menu-based prices should be. For example, some customers of our focal firm shifted their business practices, bringing them more in line with the ECR recommendations. Both parties agreed that this shifts some costs to distributor from customer and hence some compensation in the form of increased prices is justified. However, the distributor believed that a practice of imposing a constant markup was enough to compensate for

increased costs, whereas it clearly was not so, as evident from the very low profitability of some of these customers reported in the previous section.

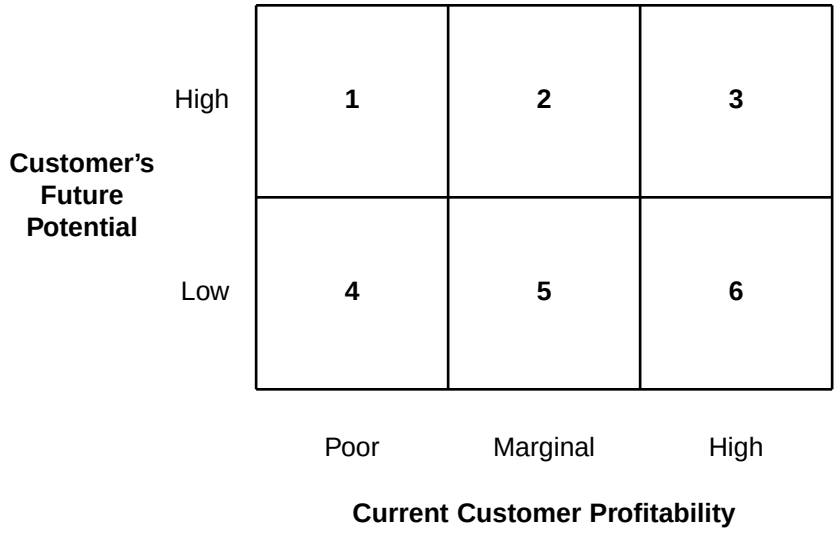
A more likely advantage of knowing these costs better is the ability to reengineer systems and incentives. For example, if certain activities are costing more than the industry standard or if certain services are more costly to provide than their value to the customer, then a customer profitability analysis is likely to point towards that. This could help the firm to think of technical improvements to reduce costs or discontinue that service. Our distributor can, for example, stop the practice of serving small walk-up customers who come to the warehouse themselves and instead steer them to one of their customers (e.g., SAM's club). Similarly, better use of EDI technology can cut down the cost of order processing.

Also, such analyses can point out the areas where, for example, the salesforce's incentives may not be aligned with the firm's bottom line and can provide management with a tool to correct the situation. If salesforce incentive is on sales revenue, they might lower prices in order to make a sale or pick up orders for special or new items which impose extra cost to maintain, even if a customer's order volume or margins do not justify maintaining the item. Customers' behavior can be steered towards more favorable characteristics if the valuation of certain services is low and changing the behavior is relatively painless. For example, a customer may not derive sufficient value from direct store delivery if there are other items, possibly supplied by other vendors, that go through a retail distribution center. Providing such a service may be costing more to the distributor and a better and cheaper way may be to discontinue the service and pass on some of the savings by way of a special discount.

Most companies with reasonable accounting systems in place should be able to generate the base information required for estimating customer profitability from existing resources. In spite of increasing interest in ABC analysis, many companies are not routinely tracking costs associated with specific activities. This can be partly blamed on the lack of detailed studies in literature that could help companies identify an approach suitable for their industry. It is our hope that we are fulfilling that need for some important industries.

We believe that customer profitability analysis is an important step in determining the LTV of customers. Linking the two aspects that go into LTV analysis, i.e., present profitability and future potential, can provide a useful way of classifying customers. The future potential should be arrived at by jointly assessing the possibility to induce favorable behavior in terms of service characteristics, forecasted revenue, and expected lifetime duration. A classification scheme is presented below:

Figure 1. A Scheme of Customer Classification



Customers in cell 4 are probably ripe to be thrown out as a group, while customers in cell 3 are best and need to be nurtured the most. Customers in cells 1, 2, and 5 should be targeted for steering the behavior to more favorable characteristics. Customers in cell 6 are the cash cows who will remain the backbone of firm's profitability, if not growth, for the long run, probably without requiring much managerial attention.

Limitations

We now briefly present certain limitations of our study. First of our two major simplifications is that the model is completely deterministic. We believe that introducing uncertainties about the customer characteristic parameters is going to make the model much more complicated but will likely not affect the conclusion qualitatively. The other simplification is linearity of cost components in terms of the respective cost drivers. In the absence of any specific information or hypothesis about the type of nonlinearity, linear in cost drivers is the most natural approximation for moderate level of activities. Note that even with this simple linear formulation, costs are nonlinear on either a per-customer or on a per-unit revenue basis. This is due to the existence of several levels of cost drivers (unit, transaction, partner, and enterprise level) and the fact that different dimensions of customer characteristics interact with these. While this may not be the most general formulation, by considering cost drivers at many levels, it represents an improvement over the existing literature on this topic.

Another possible issue is what costs to assign to customers. After ascertaining that no significant unutilized capacities exist at our site, we chose to allocate all local costs (i.e., excluding the allocated head office costs) to customers in the belief that all of it is spent to serve these customers. In general, however, the issue of capacities within the organization plays a role in determining the costs allocated to customers and hence their profitability, and one needs to be careful about not confus-

ing surplus capacity with unprofitable customers. Some small measurement issues also exist. The cost rates assigned to individual cost drivers depend on managerial estimation of cost of the activity and to that extent, they are subject to some estimation error. However, the magnitude of this is likely to be small and should not affect our results much.

A limitation that we have already recognized in presenting our results is the existence of some demand-side factors that are outside our analysis. These include serving customers or providing low prices for reasons like long-term growth potential, prestige in landing an account, externalities between customers, possible strategic issues in dealing with competitors, and different bargaining strengths vis-à-vis different customers. All these could be important in a specific situation in varying degrees and the generality of our results is somewhat limited by these. Still, our basic point of also paying attention to cost of service and widely varying profitability holds true in most situations. In fact, understanding costs better provides management with the costs of strategic benefits and allows them to make better-informed tradeoffs.

Despite these limitations in our methodology and empirical exercise, we think we have provided a rich first model and empirical support to our assertions regarding the need for careful profitability analysis at the individual customer level. We hope that our work attracts more research interest in the area and future researchers can further enrich the understanding of this area by relaxing some of the assumptions we made here for simplicity and also by using data from varied empirical contexts.

Appendix

Table of Notations

Symbol	Description
I	Number of retail customers; customers are indexed by i
s_i	Number of items ordered by retail customer i; items are indexed by s
N_i	Number of retail stores for retail customer i
m_{is}	Demand in number of units for item s in each retail store of customer I [A-1]
k_i	Number of orders placed by retail customer i in a period[A-2]
K_s	Number of orders placed by distributor on supplier of product s in a period
S_{iN}	The set of items that retail customer i buys as normal delivery item
S_{iD}	The set of items that retail customer i buys as drop shipments
S_{iT}	Union of the sets S_{iN} and S_{iD}
α_{is}	Fraction of total demand retail customer i maintains as inventory for item s
β_s	Fraction of total normal demand distributor maintains as inventory for item s
S	Total number of items handled by the distributor

[A-1] We are assuming similar stores for any given chain i for analytical simplicity.

[A-2] It is assumed that the customer consolidates the requirement of all SKUs in every purchase order.

Ordering Process

1. Each retail store generates k_i (internal or external) purchase orders (POs) per period either to the retail distribution center or to the distributor. We assume that only those individual stores that are not part of a multi-store chain interact with the distributor directly. We also assume that each store i lists its requirements of all s_i items in one PO each of those k_i times per period.

2. Each retail distribution center consolidates the requirement of all its N_i stores and all the relevant s_i items generating k_i POs to the distributor.

3. The distributor consolidates orders for each item from all its customers and places k POs each period to each manufacturer for “normal” deliveries, i.e., for delivery to the distributor’s warehouse. Note that we are assuming a different manufacturer for each item. If orders for some items from some retail customers are found to be large enough, then the distributor places a “drop-shipment” order to the supplier for each such customer. A “drop” order is, thus, processed through the distributor but delivery in the desired quantity is made directly to the retail distribution center. This implies that corresponding to the customers and items whose orders for some items are fulfilled as “drop” shipments, a total of $\sum_{i=1}^{I} \sum_{s:s \in S_{iD}} k_i$ drop orders are also placed by the distributor on suppliers every period.

Fulfillment Process

At each stage, one order is shipped in response to each PO generated in the ordering process. This means that each period, the following deliveries are made:

1. $k*S$ normal deliveries from manufacturer to the distributor
2. $\sum_{i=1}^{I} \sum_{s:s\in S_{iD}} k_i$ drop deliveries from manufacturers directly to the retail chains
3. $\sum_{i} k_i$ normal deliveries from the distributor to the retail customers (retail distribution centers or individual stores as the case may be)
4. $\sum_{i:N_i\geq 2} k_i * N_i$ deliveries from the retail distribution centers to their affiliated retail stores

Each delivery within the system requires receiving or dispatch and inbound and outbound material handling as appropriate. Also, each delivery requires transportation.

The two processes above require inventory and administrative *support services* at the respective organizations.

For the *inventory support*, we maintain the following assumptions:

1. Each customer maintains inventory (either at the retail store or at distribution center warehouse) proportional to its total demand. Across all customers, a total of $\sum_{i=1}^{I} \sum_{s=1}^{S_i} \alpha_{is} * m_{is} * N_i$ units is maintained. This inventory can be thought of as largely consisting of safety stock but also some rotating (in-transit) stock. This percentage α_{is} could then be argued to be a negative function of k_i since it is conceivable that less safety stock is needed if orders are generated more frequently.
2. In addition, the distributor also maintains an average inventory equal to $\sum_{i=1}^{I} \sum_{s:s\in S_{iN}}^{S_i} \beta_{is} * m_{is} * N_i$ for all the items that are processed as normal delivery orders through its warehouse. β_s is a item-specific constant and for reasons similar to above can also be reasonably taken as a negative function of k.

Significant accounting and administrative activities are required to maintain the ordering and physical flows smoothly. These are activities associated with vendor selection and maintenance, customer accounts maintenance, order receiving, purchasing and arranging dispatch according to the order, etc. For example, each time a PO is fulfilled, accounts receivable is generated for the seller and an accounts payable is generated for the buyer. Tallying the accounts with the physical movements in the processes above is a support function. A big part of these activities include all the account maintenance activities carried out by the field salesforce.

Notes

1. Horngren, Foster, and Datar (1997) define cost driver as “any factor that affects total costs. That is, a change in the cost driver will cause a change in the level of the total cost of a related cost object.”
2. The task of estimating customers’ lifetime duration has also attracted interest from researchers. One approach is to model this as a stochastic process (Schmittlein and Peterson 1994; Reinartz and Kumar 1999). Jones and Sasser (1995) and Reichheld and Sasser (1990) link actions taken by the firm to enhance customer satisfaction and to affect loyalty and defection behavior of customers, thus indirectly linking them to customers’ lifetime duration.
3. In expressions 1 and 2 S_{iT} is the set of items purchased by customer *i*.
4. Symbols in bracket refer to the activity codes from tables 1 and 2.
5. The Robinson-Patman Act and case law based on interpretation of this act generally consider charging different prices to different trade customers legal only if it can be justified by different costs for servicing these customers.
6. Consistent with the practice in our research site, we exclude all transportation costs from our analysis. Including those costs in the analysis is conceptually similar.
7. We tried other criteria for deciding which customers are “too small.” Our results remain largely unaffected by the choice of the criteria.
8. In calculating partial correlations between X and Y controlling for the effect of Z, both X and Y are regressed on Z separately and then correlation coefficient between the residuals for the two regressions is reported as the partial correlation coefficient between X and Y.

References

Berger, Paul D., and Nada I. Nasr (1998), "Customer Lifetime Value: Marketing Models and Applications." *Journal of Interactive Marketing* 12 (1), 17-30.

Blattberg, Robert C., and John Deighton (1996), "Manage Marketing by the Customer Equity Test." *Harvard Business Review* (July-August), 136-44.

Foster, George, and Mahendra Gupta (1998), "The Customer Profitability Implications of Customer Satisfaction." St. Louis, MO: Washington University, John M. Olin School of Business, Working paper.

Hallberg, Garth (1995), *All Customers Are Not Created Equal: The Differential Marketing Strategy for Brand Loyalty and Profits.* New York: John Wiley & Sons.

Hoffman, Thomas (1998), "Poor Profit Data Weakens Business." *Computerworld*, Framingham (April 6), 39-41.

Horngren, Charles T., George Foster, and Srikant M. Datar (1997), *Cost Accounting: A Managerial Emphasis*, 9th ed. Upper Saddle River, NJ: Prentice Hall.

Innes, J., and F. Mitchell (1995), "A Survey of Activity Based Costing in the U.K.'s Largest Companies." *Management Accounting Research* 6 (2) (June), 137-53.

Ittner, Christopher D., and David F. Larcker (1998), "Innovations in Performance Measurement: Trends and Research Implications." *Journal of Management Accounting Research* 10, 205-38.

Jackson, B. (1985), *Winning and Keeping Industrial Customers.* Lexington, MA: Lexington Books.

Jones, T., and Sasser, W. E. Jr. (1995), "Why Satisfied Customers Defect." *Harvard Business Review* (November-December), 88-99.

Kaplan, Robert S., and Robin Cooper (1997), *Cost & Effect: Using Integrated Cost Systems to Drive Profitability and Performance*. Boston: Harvard Business School Press.

Kerr, Ruby (1998), "Gaining an Understanding of Your Customers Using Portfolio Analysis." *Business Credit,* New York (July/August), 43-7.

Kurt Salmon Associates, Inc. (1993), "Efficient Consumer Response : Enhancing Consumer Value in the Grocery Industry." Washington, DC: Food Marketing Institute.

Mulhern, Francis J. (1999), "Customer Profitability Analysis: Measurement, Concentration, and Research Directions." *Journal of Interactive Marketing* 13 (1), 25-40.

Peppers, Don, and Martha Rogers (1993), *The One to One Future: Building Relationships One Customer at a Time.* New York: Doubleday & Co.

Post, Carol (1997), "Finding Your Best Customers," *Target Marketing*, Philadelphia (August), 38-42.

Reichheld, F., and Sasser, W. E. Jr. (1990), "Zero Defections: Quality Comes to Services." *Harvard Business Review* (September-October), 105-11.

Reinartz, Werner J., and V. Kumar (1999), "Customer Lifetime Value : An Empirical Framework for Measurement and Explanation." Houston, TX: University of Houston, College of Business Administration, Department of Marketing, Working paper.

Schmittlein, David C., Cooper, L. G., and Morrison D. G. (1993), "Truth in Concentration in the Land of (80/20) Laws." *Marketing Science* 12, 167-83.

Schmittlein, David C., and Robert A. Peterson (1994), "Customer Base Analysis : An Industrial Purchase Process Application." *Marketing Science* 13, 41-67.

Shields, Michael D. (1997), "Research in Management Accounting by North Americans in the 1990s." *Journal of Management Accounting Research* 9, 3-61.