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The effect of shipping fees on customer acquisition, customer retention, and purchase quantities

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Abstract

The growth of the e-commerce sector has highlighted the importance of shipping fees. We empirically study the effects of shipping fees and marketing activities on customer acquisition, customer retention, and average expenditures using data from an online grocer. We find that shipping fees greatly influence order incidence rates and graduated shipping fees significantly affect average expenditures. The analysis indicates that customer acquisition is more sensitive to order size incentives while retention is more influenced by base shipping fee levels. Furthermore, a profitability analysis suggests that shipping policies that provide incentives for larger order sizes may outperform free shipping promotions and standard increasing fees structures.

Keywords: Shipping fees; E-commerce; Customer acquisition; Customer retention

Introduction

The growth and evolution of the e-commerce sector has highlighted the importance of shipping and handling (S&H) fees for business models that involve a spatial separation between customers and retailers. The existence of a physical separation between customers and products creates order assembly and transportation costs that are not present in traditional retailing (Rosen and Howard 2000; Sawhney 1999). These added costs are often large enough that firms have strong incentives to charge S&H fees. However, charging for order fulfillment can be an uncertain proposition. Survey evidence indicates that shipping fees are the main complaint of more than 50 percent of online shoppers and that more than 60 percent of shoppers have abandoned an order when shipping fees are added (Jupiter 2000; Ernst and Young 1999). Academic work has further confirmed that fulfillment issues are a key driver of customer satisfaction (Trocchia and Janda 2003). In this paper, we study how shipping fee schedules impact customer acquisition, customer retention, and order size.

While a desire to recover fulfillment costs might suggest charging high shipping fees, these fees can adversely affect order incidence rates. By acting as a required transaction fee, shipping surcharges may deter ordering by current and prospective customers. Shipping fees can also impact order size by providing incentives or penalties for different order quantities. For example, a common practice is to waive shipping fees for orders that reach some dollar amount threshold (Courogen 2002; Wingfield 2003). These policies can induce larger orders by creating circumstances where the marginal cost of an incremental item to a basket can be low or negative. Another common practice is graduated fee schedules that discontinuously increase fees as order size increases. These schedules can lead to reduced order quantities by penalizing larger baskets.

The relationship between shipping fees and shipping costs can also significantly impact profitability (Pyke et al. 2001). A review of online retailers found average fulfillment costs ranged from $28 for grocers to $15 for drugstores (Barsh et al. 2000). These costs resulted in many early e-retailers losing between $4 and $16 per order even while charging fees. The complexity of consumer response to shipping fees and the profitability consequences have created an uncertain environment for remote retailers. This uncertainty has led firms ranging from Domino's Pizza to Amazon.com to

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experiment with shipping fees (CNN.com 2002, Wingfield 2003). Amazon's chief executive described the purpose of the company's shipping fee experiments with the following statement: "We'll be looking to see if our current customers order more from us and whether we attract a greater number of new customers." This quote highlights that, in addition to questions about how shipping fees influence order incidence and size, there are questions about the influence of shipping fees on customer acquisition.

Shipping fees are, therefore, relevant to the larger issue of how marketing tactics impact customer acquisition (Thomas 2001) and repeat buying (Hsieh et al. 2005; Srinivasan et al. 2002). Discussions of customer acquisition and retention have tended to focus on the differences in the cost to acquire a customer versus the cost to retain a customer. While the conventional wisdom is that it costs considerably more to acquire than to retain a customer (Peppers and Rogers 1993), it is often a difficult empirical task to separate acquisition and retention efforts (Thomas 2001). Shipping fees are a case in point since shipping fee structure may influence the behavior of both existing and potential customers. For managers interested in acquisition and retention, it may be useful to know the relative responsiveness of prospects and existing customers to marketing mix elements.

The discussion thus far highlights the importance of shipping fees and also foreshadows potential empirical challenges. We have noted that shipping fee structures can simultaneously affect order size and incidence. We have also speculated that S&H fees may differentially impact customer acquisition and retention. The situation may be even more complex if new customers tend to select different sizes of orders than repeat buyers. To understand the effects of shipping fees on order size, customer acquisition, and store order volume, it is necessary to consider the simultaneous nature of these dependent measures.

In this paper, we investigate the relationship between shipping fees and these multiple outcomes using data from an online grocery retailer.[1] A key aspect of the data is that the retailer has used multiple shipping fee schedules. A second important characteristic of the data is that it begins from the firm's entry and includes sufficient detail to study the response of the extant customer base and the firm's ability to acquire new customers. We address the simultaneous nature of these effects as well as the possibility of endogenous explanatory variables by specifying a system of interrelated equations and using three-stage least squares (3SLS) for the estimation. In addition, we also examine the elasticity of order size and order incidence to shipping fees for both existing and prospective customers.

Our results confirm that shipping fees have a significant impact on order incidence and order size. We find that higher shipping fees are associated with reduced ordering rates, and policies that penalize larger orders lead to reduced order size. In terms of elasticities, we find that new customers are more responsive to order size incentives while existing customers are more responsive to the base level of shipping fees. The use of a system of equations also enables comparison of the daily contribution generated by different shipping policies. In particular, we find a policy that waives shipping fees for larger orders results in greater net revenues than free shipping or a policy of shipping fees that strictly increases as order size increases.

The paper is organized as follows. The "Literature" section briefly reviews the marketing and economics literatures relevant to consumer response to shipping fees. The "Data" section describes our data, provides summary statistics, and discusses how we expect customer behavior to be influenced by various marketing mix elements. The "Empirical analysis" section presents the estimation results and corresponding elasticity measures. The "Discussion" section concludes the paper with a discussion of managerial issues, limitations of the study, and areas for future research.

Literature

We begin by discussing several results from the marketing and economics literatures that are pertinent to store traffic, quantity decisions, and customer acquisition. Since the primary goal is to identify findings relevant to consumer reaction to nonlinear shipping fee schedules, the review is therefore limited to factors that may influence incidence and size decisions. Additional material related to the overall managerial importance of shipping fee structures is presented in the "Discussion" section.

Store traffic/order incidence

Our joint emphasis on customer retention and customer acquisition means that our work is related to the literature on store traffic (see Neslin 2002 for a review). Previous empirical work on store traffic effects has emphasized consumer response to promotions. For instance, Walters and MacKenzie (1988), Walters and Rinne (1986), Gijsbrechts et al. (2003), and Lam et al. (2001) investigate the role of weekly promotional activity on store traffic while Bell and Lattin (1998) evaluate the impact of overall promotional strategy (EDLP vs. Hi/Lo) on large- and small-basket customers. Our work complements this literature by studying how store traffic in an online environment is related to shipping fee structures and other marketing mix elements. An important advantage of our data, which include individual level ordering activity from the beginning of the firm's operations, is

[1] Online grocery retailing has been frequently discussed over the past few years since several prominent failures in the online sector were grocers such as Webvan and Streamline. However, online grocery retailing is now steadily growing with Freshdirect, Peapod, and Safeway.com each approaching annual revenue of $500 million (Schmeltzer 2004). Current forecasts for the online grocery market range from $5.4 billion (Jupiter Research) to $18.2 billion (Forrester Research) by 2007. For reference, the total U.S. grocery market is roughly $535 billion per year.

that we have an opportunity to decompose store traffic into repeat buyers and new customers. This is an important distinction since it helps connect store traffic results to customer management metrics.

Shipping fees, like promotions, are an element of price. Shipping fees may reduce order volume because higher delivery surcharges increase the sacrifice asked of the consumer without changing the utility of the products received. However, there are important reasons for investigating the relationship between order incidence and shipping fees. First, the level of experimentation occurring in the marketplace (CNN.com 2002; Courogen 2002) suggests that there is significant uncertainty regarding the elasticity of demand to shipping fee levels. Second, while shipping fees are an element of price, S&H fees are an example of a partitioned price where total price is divided into a base price and a secondary surcharge. Morwitz et al. (1998) examined the impact of partitioned pricing structures in a laboratory setting and found that partitioned prices can lead to more favorable evaluations of an offering because consumers tend to underweight the second component of price. Since shipping fees are not directly associated with merchandise and are often added at the end of a transaction, they may be overlooked by consumers. The partitioned pricing structure of shipping fees may, therefore, moderate consumer response to S&H fees. An alternative hypothesis is that the increased attention to shipping fees in the online environment may heighten the salience of these fees to consumers.

Order size

Another important characteristic of shipping fee schedules is that shipping charges often impose an element of nonlinear pricing on otherwise straightforward transactions. By imposing extra charges (or providing discounts) based upon order size thresholds, shipping fees can change the marginal price of incremental units of merchandise. Furthermore, while nonlinear pricing is a common practice in a wide range of industries (Dolan and Simon 1996) and has been extensively studied using analytical methods (see Wilson 1993), there is limited empirical research examining consumer reactions to nonlinear pricing schemes (Lewis et al. 2006).

Previous work focused on empirically measuring the effect of nonlinear pricing schedules includes work by Train et al. (1987, 1989) that studies the selection of telephone calling plans by residential users. These papers utilize nested logit models to replicate the multilevel structure of a consumer first choosing a rate plan and then subsequently choosing the level of calling. An interesting finding in these papers is that self-selection mechanisms can make it difficult to increase revenues because consumers tend to switch to flat-rate plans in response to increased usage charges.

This finding provides empirical support to an extensive analytical literature (Wilson 1993), which suggests that consumers will alter behavior in response to nonlinear pricing schedules. The implication is that shipping fee schedules that provide penalties (benefits) for larger orders will cause consumers to shift to smaller (larger) order sizes. In this way, shipping fee schedules can provide direct economic incentives for consumers to alter purchase quantities. The issue of self-selection is also important from a customer acquisition perspective. Shipping fee schedules that provide incentives for certain order sizes are likely to attract prospective customers with corresponding order size preferences. A long-run benefit of a structure that waives shipping for large orders might be a customer base largely comprised consumers with innate preferences for large order sizes.

Shipping fees may also affect order size through their relative or percentage impact on consumer expenditures. Shipping fees often resemble two-part tariffs in which the shipping fee represents a fixed fee and the consumer then chooses a quantity of merchandise (Dolan 1987). Flat or fixed shipping fees can act as quantity discounts (Dolan and Simon 1996) since customers who prefer larger orders receive better value. For example, if shipping fees are a constant $5, a customer buying $100 of merchandise is paying a 5 percent surcharge while a customer buying $10 of merchandise is paying a 50 percent surcharge.

More generally, graduated schedules with discontinuous fee changes can have complex effects involving both order size penalties and quantity discounts. For example, a schedule that charges $5 to ship orders of less than $50 and $7 to ship orders above $50 provides quantity discounts as orders increase from $0 to $50. At the point where an item causes the $50 threshold to be crossed, the shipping schedule inflicts a $2 penalty. As order amount increases beyond $50 the shipping fee structure again acts as a quantity discount.

In contrast to the notion that consumers "optimize" by minimizing the percentage impact of shipping fees, there is research that suggests consumers often behave sub-optimally in these types of situations. Specifically, there is evidence that consumers have difficulty with proportionality calculations (Capon and Kuhn 1982) and often make suboptimal choices when confronted with nonlinear pricing schedules (Nunes 2000). These types of errors would moderate the impact of shipping fees on order amount.

Customer acquisition and retention

Another salient question is whether shipping fees differentially influence customer acquisition and retention. Customer acquisition and retention are areas that are receiving increasing attention from researchers (Thomas 2001; Reibstein 2002; Niren et al. 1998; Jones et al. 2000; Lewis 2004). However, the joint analysis of acquisition and retention is often difficult since it requires specially tailored datasets. Pure aggregate-level data often lack sufficient detail regarding activity by prospects versus repeat buyers while panels of individuals typically lack the necessary aggregate measures. Our data, detailed in the next section, include sufficient aggregate and individual level data to assess both repeat buying and acquisition rates.

Table 1
Descriptive statistics

	Schedule 0 (Days 1–40)	Schedule 1 (Days 41–137)	Schedule 2 (Days 138–200)	Schedule 3 (Days 201–328, 350–487)	Schedule 4 (Days 329–349)	Schedule 5 (Days 488–502)
Shipping fees for various order sizes ($)						
0–50	3.99	4.99	4.99	2.99	0	5.99
50–75	0	6.97	6.97	4.99	0	7.99
75 plus	0	0	8.95	4.99	0	9.99
Average price ($)	1.96	1.91	1.89	1.92	1.90	2.16
Average order		$64.68 (11.93)	$56.05 (8.79)	$48.28 (7.00)	$46.04 (8.67)	$54.16 (8.47)
Orders received[a]		.089	.082	.093	.140	.025
Customers acquired		.059	.045	.044	.072	.006
Inter-purchase time in weeks		3.43 (2.57)	3.77 (3.19)	3.89 (3.91)	3.70 (3.30)	3.55 (3.51)

[a] Numbers of orders and customers acquired are given as a percentage of the existing customer base. The average price is the average price of the top 50 selling UPCs over the entire data collection period. The variation in this measure is primarily due to weekly promotional activity.

The partitioned pricing work of Morwitz et al. (1998) may provide an explanation for possible differences in behavior between existing and prospective customers. One initial conjecture is that differences in experience may lead prospective customers to be more likely to systematically underweight shipping and handling fees. This conjecture is based on the finding (Morwitz et al. 1998) that the second part of a partitioned price is often underweighted. This underweighting may be more likely to occur with new customers since existing customers, through previous experience with the firm, will be more familiar with total expenses. Based on this reasoning, repeat buying may be more sensitive to shipping fees than customer acquisition.

Implicit in the preceding argument is the belief that consumers learn or resolve uncertainty through the act of purchasing. Similarly, consumers may evaluate an initial transaction fully aware they are uncertain of product or service quality (Cyert and deGroot 1975; Cohen and Axelrod 1984). In models based on utility theory, a common assumption is that individuals know their utility functions and can calculate the utility to be gained from any choice. In reality, initial purchases may involve a significant element of risk.

In many circumstances, including our empirical setting, online retailers emphasize merchandise with well-known brand names. Lack of experience with the firm may, therefore, lead prospects to be especially focused on a firm's shipping policies since the majority of the uncertainty associated with a purchase is related to the service provided by the retailer rather than with the quality of the merchandise. Because the perceived risk of ordering is expected to be greater for prospects than experienced customers, prospects may be more sensitive to shipping fees. These contradictory conjectures, based on the effects of partitioned prices and initial uncertainty, highlight the need for empirical study of customer acquisition.

The notion that prospects may be less certain about the retailer can also have implications for average order size. Since prospects are more likely to be uncertain about quality of service, new customers may select relatively small initial purchases to mitigate risk. A tendency for new customers to purchase smaller quantities would mean the policies that tend to encourage customer acquisition would also result in smaller order sizes. Reichheld and Teal (1996) provide empirical evidence that customer expenditures tend to increase with time as a customer in wide range of industries. Marketing policies that increase customer acquisition may, therefore, have the unintended effect of reducing average order size.

Data

The data examined are from an Internet retailer specializing in non-perishable grocery and drugstore items. Specialization in non-perishable items allows the firm to pursue a logistics system that is fairly different from most online grocers but similar to other online retailers. Unlike most online grocers, the firm operates from a single distribution center and uses third-party delivery services. The dataset includes information on daily orders for the retailer's first 502 days of operation.[2] Over the course of this time period, the firm's customer base increased from 0 to more than 30,000, and the average order size over the 502 days was $51.20. An important aspect of the data is that the firm experimented with multiple shipping fees schedules. Descriptions of these schedules and additional summary statistics are provided in Table 1.

The dependent measures of interest are the number of daily orders received from the established customer base, the number of new customers acquired, the average order sizes for new and repeat customers, and the net subsidy (profit) related to shipping. The first four of the measures are self-explanatory while the shipping subsidy merits further explanation. As noted, many e-retailers have subsidized shipping fees by providing shipping services at prices below actual shipping costs. Any discussion about the relationship between shipping fees and profitability consequently needs to consider gains or losses related to the shipping function.

[2] Order volume was very low during the first schedule. The first 40 days of data are not used in the estimation.

The dependent measure we consider is the difference between the fees paid by the consumer and the firm's marginal cost to ship the product. This means we consider only the firm's expenses for shipping services and do not incorporate fixed costs associated with the logistics function.

The various S&H schedules used by the firm are detailed in Table 1. The table lists each schedule by number and reports the fees for shipping various order sizes. For example, Schedule 1 charged $4.99 to ship an order of less than $50, $6.97 to ship an order of between $50 and $75, and $0 to ship an order that contains at least $75 worth of merchandise. Schedule 1 is of particular interest because it includes an element of decreasing per unit fees, or order size incentives, since the largest order size category is assessed the lowest fee. Schedules 2, 3, and 5 may be described as increasing fee schedules. These schedules primarily differ in terms of the magnitude of the fees charged. Schedule 3 charges the lowest fees while Schedule 5 charges the highest (approximately double the fees charged in Schedule 3). Schedule 4 is unique since all order sizes are charged the same fee, and the fixed fee for all order sizes is zero.

Table 1 also provides summary measures of consumer demand for the shipping schedules. The table includes the average order size and information concerning daily orders and customer acquisition rates. Daily orders and customers acquired are given as a percentage of the existing customer base to account for differences in the size of the customer base at the times when each shipping schedule was employed. These summary measures provide some evidence regarding the conjectured relationships between shipping fees and consumer demand. For example, the free shipping policy generates the highest levels of order incidence while Schedule 1, which involves order size incentives, results in the largest average order sizes by more than $8. Table 1 also lists the average and standard deviation of inter-purchase times that occurred during each shipping schedule.

In addition to the shipping fees, the data include information about several aspects of the marketing mix. Descriptions of the available covariates are given in Table 2. A key marketing mix variable is the pricing variable, which is computed as the average daily price of the 50 top-selling items over the data collection period, which provides a measure of weekly price levels and promotional activity. In addition, we have information related to e-mail-based promotions, banner advertising[3], and the size of the customer base.

An additional factor worth considering is the possible relationship between the different marketing mix factors. In the classic partitioned pricing case described by Morwitz et al. (1998), the firm decides the allocation of a fixed total price to the product and to the required surcharge. In the case of shipping fees, the firm could balance reduced merchandise prices with higher shipping fees or vice versa. Alternatively, shipping fees and prices may be managed separately. Table 3 provides the correlations of the pricing variable and the shipping fees for each order size. There is little correlation between the fees for shipping small and medium orders and product prices. There is some evidence of a significant correlation between the fee for shipping a large order and merchandise prices. However, in all three cases the direction of the correlation is positive. This indicates shipping fees and prices tend to move in the same direction. This is at odds with the idea of allocating a fixed total price between product and shipping and more consistent with a strategy of influencing demand by altering the overall price level.

Table 2
Covariate descriptions

	Definition
Price (*P*)	Average daily price of 50 top-selling items
E-mail coupons (*E*)	Binary variable that indicates an e-mailed coupon providing a 10 percent discount on merchandise is available to existing customers
Customer base (CB)	The number of individuals who have previously purchased
Customer base squared (CB^2)	CB^2. This term is included to reflect that as a customer base grows, it may also include a growing number of non-active customers
Banner advertising (Ad)	Number of click-throughs from banner ads each day
Shipping fee for a small order (SH_{small})	Surcharge for shipping an order of less than $50
Shipping fee for a medium order (SH_{med})	Surcharge for shipping an order of between $50 and $75
Shipping fee for a large order (SH_{lrg})	Surcharge for shipping an order that exceeds $75

Table 3
Correlation of shipping fees and prices

Shipping fee	Correlation with price	*p*-value (H0: $\rho = 0$)
SH_{sm}	.047	.306
SH_{med}	.043	.342
SH_{lrg}	.122	.068

Empirical analysis

Our discussion thus far suggests shipping and handling fees can have multiple and potentially conflicting effects. This finding makes the design of a shipping fee schedule a complex task that requires balancing order incidence, order size, shipping revenues, and customer acquisition. It is therefore necessary to simultaneously examine the impact of shipping fees on these multiple outcomes. In this section, we present our empirical specification and the estimation results.

[3] The data on banner advertising is the number of customers that click-through to the firm. This measure is, therefore, an outcome of advertising rather than a direct indicator of the advertising effort and is included as a control variable.

Empirical specification

Our empirical specification includes equations for repeat buying, customer acquisition, purchase quantities (for repeat and new customers), and shipping contribution. The equations are treated as a system in an effort to control for possible relationships between the dependent measures. Before we detail the specific equations, we discuss issues related to the inclusion of the shipping fee covariates.

For the empirical specification, we do not use the shipping fees directly as covariates. Instead, we use a specification designed to account for the two-part pricing and order size incentive aspects. We define the value of shipping an order of less than $50 as the level of base shipping charges. The other shipping fees are then used to create variables that reflect the penalties (or incentives) associated with larger orders. The resulting three variables are defined below in Eqs. (1), (2) and (3).

$$\mathrm{SH}_{\mathrm{base}} = \mathrm{SH}_{\mathrm{small}} \tag{1}$$

$$\mathrm{SHpen}_{\mathrm{med}} = \mathrm{SH}_{\mathrm{med}} - \mathrm{SH}_{\mathrm{small}} \tag{2}$$

$$\mathrm{SHpen}_{\mathrm{lrg}} = \mathrm{SH}_{\mathrm{lrg}} - \mathrm{SH}_{\mathrm{med}} \tag{3}$$

We also define a set of variables to capture possible reference effects related to the shipping fees. As with other elements of the marketing mix, shipping fee policies may create expectations of what shipping fees should be. As such, shipping fee policies may create reference effects (Kalyanaram and Winer 1995) that can magnify response to changes in shipping fee structure. In other words, consumer reaction to a shipping fee schedule may be based on both the current fee structure and also some function of the past fee structure(s). As a summary measure we define $\mathrm{SH}_{\mathrm{tot}}$ to be the sum of the three order size fees.

$$\mathrm{SH}_{\mathrm{tot}} = \sum_{k \in \{\mathrm{small,med,lrg}\}} \mathrm{SH}_k \tag{4}$$

This variable is used to compute a change in fees variable[4], SHΔ as

$$\mathrm{SH}\Delta = \mathrm{SHtot}_{\mathrm{cur}} - \mathrm{SHtot}_{\mathrm{prev}} \tag{5}$$

We also create variables that interact the shipping fee change with the number of weeks (WK) since a change occurred $\{\mathrm{SH}\Delta \times \mathrm{WK}$ and $\mathrm{SH}\Delta \times \mathrm{WK}^2\}$.

Eq. (6) models the number of daily orders received from the existing customer base (Rbuy) as a function of the average price of the 50 top-selling items, the base level of shipping fees, the order size penalty terms, and the e-mail promotions indicator. This equation also includes terms that reflect the size of the customer base and the square of the customer base. The quadratic formulation is included to account for diminishing effects of customer base size due to growth in inactive customers over time. To account for shipping fee reference effects, the equation also includes the shipping fee change variable, interactions between the change variable and the weeks since a policy takes effect, and the squared number of weeks. The weeks and squared weeks are included to account for the possibility of diminishing reference effects over time.

$$\begin{aligned}\mathrm{Rbuy} = {} & \beta_1 + \beta_{1,P}P + \beta_{1,\mathrm{base}}\mathrm{SH}_{\mathrm{base}} + \beta_{1,\mathrm{med}}\mathrm{SHpen}_{\mathrm{med}} \\ & + \beta_{1,\mathrm{lrg}}\mathrm{SHpen}_{\mathrm{lrg}} + \beta_{1,\mathrm{CB}}\mathrm{CB} + \\ & \beta_{1,\mathrm{CB}^2}\mathrm{CB}^2 + \beta_{1,E}E + \beta_{1,\Delta}\mathrm{SH}\Delta + \beta_{1,\Delta\mathrm{WK}}\mathrm{SH}\Delta \\ & \times \mathrm{WK} + \beta_{1,\Delta\mathrm{WK}^2}\mathrm{SH}\Delta \times \mathrm{WK}^2 + \varepsilon_1\end{aligned} \tag{6}$$

The expression for customer acquisition (CAcq) given in Eq. (7) includes the shipping, pricing, and customer base terms but excludes the e-mail coupon and reference price terms. The e-mail-based coupons are excluded because the offers are distributed only to existing customers. The logic for including the customer base terms is somewhat different for the customer acquisition equation than in the repeat buying equation. In this equation, the customer base terms are meant to account for word-of-mouth effects. The customer acquisition equation also includes the number of customers who visit the site by clicking on a banner advertisement.

$$\begin{aligned}\mathrm{CAcq} = {} & \beta_2 + \beta_{2,P}P + \beta_{2,\mathrm{base}}\mathrm{SH}_{\mathrm{base}} + \beta_{2,\mathrm{med}}\mathrm{SHpen}_{\mathrm{med}} \\ & + \beta_{2,\mathrm{lrg}}\mathrm{SHpen}_{\mathrm{lrg}} + \beta_{2,\mathrm{Ad}}\mathrm{Ad} + \beta_{2,\mathrm{CB}}\mathrm{CB} \\ & + \beta_{2,\mathrm{CB}^2}\mathrm{CB}^2 + \varepsilon_2\end{aligned} \tag{7}$$

The equations for average order size for existing customers {Amount (exist)} and new customers {Amount (new)} are given in Eqs. (8) and (9) and include the shipping fee variables and the pricing variable. The expression for existing customers also includes the shipping fee reference terms and the e-mail coupon variable.

$$\begin{aligned}\mathrm{Amount\,(exist)} = {} & \beta_3 + \beta_{3,\mathrm{base}}\mathrm{SH}_{\mathrm{base}} + \beta_{3,\mathrm{lrg}}\mathrm{SHpen}_{\mathrm{lrg}} \\ & + \beta_{3,\mathrm{med}}\mathrm{SHpen}_{\mathrm{med}} + \beta_{3,P}P + \beta_{3,\Delta}\mathrm{SH}\Delta + \\ & (\beta_{3,\Delta\mathrm{WK}}\mathrm{SH}\Delta \times \mathrm{WK}) + (\beta_{3,\Delta\mathrm{WK}^2}\mathrm{SH}\Delta \times \mathrm{WK}^2) + \varepsilon_3\end{aligned} \tag{8}$$

$$\begin{aligned}\mathrm{Amount\,(new)} = {} & \beta_4 + \beta_{4,\mathrm{base}}\mathrm{SH}_{\mathrm{base}} + \beta_{4,\mathrm{lrg}}\mathrm{SHpen}_{\mathrm{lrg}} \\ & + \beta_{4,\mathrm{med}}\mathrm{SHpen}_{\mathrm{med}} + \beta_{4,P}P + \varepsilon_4\end{aligned} \tag{9}$$

The equation for shipping contribution (Ship$) includes the three shipping variables and the overall average daily order size. The shipping fee terms address the revenue collected by the shipping function while the average amount term impacts the cost side.

$$\begin{aligned}\mathrm{Ship\$} = {} & \beta_5 + \beta_{5,\mathrm{base}}\mathrm{SH}_{\mathrm{base}} + \beta_{5,\mathrm{lrg}}\mathrm{SHpen}_{\mathrm{lrg}} \\ & + \beta_{5,\mathrm{med}}\mathrm{SHpen}_{\mathrm{med}} + \beta_{5,\mathrm{amt}}\mathrm{Amount} + \varepsilon_5\end{aligned} \tag{10}$$

[4] This is an imperfect measure since, for example, if a schedule change involved the fee to ship a small order increasing by $1 and the fee for a large order decreasing by $1, the SHΔ term would indicate no change. Another intuitive specification would be to use all three shipping fee changes and the corresponding time interactions. This approach adds eighteen additional parameters but did not meaningfully improve model fit. For example, in the two-stage estimates, the use of all shipping fee changes and time interactions results in a lower adjusted R-Sq for the repeat buying traffic.

Table 4
Predicted effects

Variable	Repeat buying	Customer acquisition	Order size (existing)	Order size (new)	Shipping contribution
Price (P)	Negative	Negative	?	?	
E-mail Coupons (E)	Positive		?		
Customer Base (CB)	Positive	Positive			
Customers Squared (CB^2)	Negative	Negative			
Banner advertising (Ad)		Positive			
Shipping fee for small order (SH_{sm})	Negative	Negative	Positive	Positive	Positive
Penalty ($SH_{med} - SH_{sm}$)	Negative	Negative	Negative	Negative	Positive
Penalty ($SH_{lrg} - SH_{med}$)	Negative	Negative	Negative	Negative	Positive
Ship fee change ($SH\Delta$)	Negative		Positive		
$SH\Delta \times WK$[a]	?		?		
$SH\Delta \times WK^2$	?		?		
Average amount					?

[a] Number of weeks.

The discussion in the "Literature" section and descriptive statistics provided in the "Data" section enable some speculation about the anticipated effects of each variable on the dependent measures. Table 4 lists the predicted effects of the covariates on each dependent measure as positive, negative, or a question mark. Question marks indicate that we lack sufficient theoretical arguments to make a prediction. Blank cells indicate that the covariate is not used to predict a given dependent measure.

Estimation

The specification of a system of simultaneous equations necessitates the use of two technical refinements relative to OLS estimation. First, the estimation needs to be adjusted to consider the possible correlation between the various equations. Second, it may be beneficial to account for the possibility of endogenously determined explanatory variables. For example, since price and demand are likely to be simultaneously determined, it may be necessary to treat the price measure as an endogenous variable. The issue with using endogenous variables as explanatory variables is, because the endogenous variables are determined within the system, they may be correlated with the residual terms. If this is the case, the use of OLS will result in parameter estimates that are biased and inconsistent (Amemiya 1985).

To account for these two concerns, estimation of the system of equations is conducted using three-stage least squares (Amemiya 1985). Three-stage least squares accounts for correlations between equations and enable the use of instrumental variables for endogenous factors. For our application,

Table 5
Estimated coefficients

Variable	Repeat buying incidence	Customer acquisition	Average order (repeat)	Average order (new)	Ship fee contribution
Intercept	114.52^{***} (39.20)	106.70^{**} (48.30)	42.52^{***} (12.24)	38.14^{***} (9.45)	-6.44^{***} (0.25)
Base shipping	-7.80^{**} (3.34)	−1.76 (2.11)	3.71^{***} (0.51)	1.32^{***} (0.32)	0.68^{***} (0.04)
Ship premium (med)	−0.96 (1.79)	-2.72^{*} (1.60)	-1.73^{***} (0.28)	-2.95^{***} (0.22)	0.69^{***} (0.02)
Ship premium (large)	-1.44^{**} (0.62)	-2.04^{**} (0.66)	-0.52^{***} (0.17)	-2.03^{***} (0.12)	0.43^{***} (0.013)
Price (P)	-50.44^{**} (21.60)	-59.82^{**} (25.42)	0.91 (6.34)	5.82 (4.93)	
E-mail coupon (E)	22.62^{***} (5.45)		0.39 (1.71)		
Customer base (CB)	$.0087^{***}$ (.0015)	0.014^{***} (0.0012)			
Customer base squared (CB^2)	-6.31×10^{-8} (4.64×10^{-8})	$-3.0 \times 10^{-7***}$ (3.3×10^{-8})			
Banner advertising (Ad)		0.09 (0.077)			
Ship change ($SH\Delta$)	0.12 (0.40)		0.018 (.12)		
WK × ship change	0.067 (0.088)		0.091^{***} (.026)		
WK^2 × ship change	−0.0030 (.0056)		$-.0045^{***}$ (.0013)		
Average amount					-0.019^{***} (0.0052)
Observations	462	462	462	462	462
Two-stage R^2	.905	.760	.500	.649	.891
System weighted R^2	.789				

* $p < .1$.
** $p < .05$.
*** $p < .01$.

Table 6
Selected elasticities[a]

Variable	Incidence		Test of equivalence
	Repeat buying	Customer acquisition	
Base shipping	−0.288	−0.090	$F = 1.58$ ($p = .201$)
Ship premium 1	−0.024	−0.093	$F = 4.64$ ($p = .031$)
Ship premium 2	−0.035	−0.069	$F = 4.15$ ($p = .042$)
Price	−1.190	−1.959	$F = 1.50$ ($p = .221$)
Variable	Average amount		Test of equivalence
	Repeat customers	New customers	
Base shipping	0.206	0.073	$F = 11.27$ ($p = .0008$)
Ship premium 1	−0.064	−0.109	$F = 28.28$ ($p = .0001$)
Ship premium 2	−0.019	−0.075	$F = 89.39$ ($p = .0001$)
Price	0.032	0.207	$F = 0.59$ ($p = .4435$)

[a] Elasticities are calculated at the mean value of covariates. Significance tests are conducted using an *F*-test of the joint hypothesis of elasticity equivalence.

average order size and prices are treated as endogenous variables with lagged values of each quantity used as instruments. The insight behind the use of lagged variables as instruments is that the lagged measures are predetermined (not simultaneously determined) and are, therefore, uncorrelated with the error terms. The resulting parameter estimates are presented in Table 5.

Order incidence results

In the equation for repeat buying, the price and the shipping fee terms are negative. These terms are significant with the exception of the shipping premium associated with a medium-sized order. This is not surprising given the primary effect on order incidence is expected to be through the base shipping fee term. The penalty terms are less salient because consumers can avoid the penalties by limiting order size. The estimated parameters for the e-mail coupons and the size of the customer base are positive and significant. The squared value of the customer base is as expected (negative) but is not significant. The pattern of signs for the customer base terms are consistent with the notion that customer base size is positively related to order volume from the extant customer base but that the rate of growth is less than linear due to increasing number of inactive customers in the database. The shipping fee reference terms are all insignificant.[5]

The customer acquisition equation suggests that customer acquisition is a positive function of the size of the customer base and the level of banner advertising. In contrast, higher shipping fees and prices reduce customer acquisition rates. Interestingly, while the shipping size penalty terms are significant, the base shipping coefficient is not. The implication is that the steepness of a shipping fee schedule has a greater impact on customer acquisition than the level of fees. The customer base and customer base squared terms possess the same pattern of signs as in the repeat buying equation. These signs suggest word-of-mouth effects increase with the size of the customer base, but again the effect is less than linear. The banner advertising term possesses a positive sign but is not significant.

Order size results

The third and fourth equations model average daily order size for repeat and new customers. Both expressions yield the same pattern of signs for the base shipping fee and shipping penalty terms. The coefficient for the base shipping fee is positive and significant while the coefficients for the terms that reflect the order size penalties are negative and significant for both populations.

These results are consistent with our conjectures about the effects of the two-part tariff structure and discontinuous nature of shipping fees. The base level has a positive sign because as order size increases the fixed nature of the base fee results in quantity discounts. The negative signs on the penalty terms imply that shipping fees are not overlooked when determining order size. In sum, both existing and first time customers respond to order size incentives and higher base shipping fees lead to larger orders. In addition, a comparison of the two equations shows that new customers tend to place smaller orders. Price levels and e-mail coupons do not have a significant effect on order size.

Net shipping contribution

The final equation relates to the per-order contribution of the shipping function. The results indicate that on a per-order-basis, increased shipping fees result in greater profitability (or at least lesser losses). Average order amount is also included in this equation and has a negative effect, indicating that a consequence of larger order sizes is increased shipping costs. This finding is consequential in that it implies consumer order size decisions made in response to shipping fee schedules can also result in higher costs. The negative intercept in this equation corresponds to the expected shipping subsidy under a free shipping policy.

[5] In addition to the terms in the final model, other variables were tested. For instance, banner advertising response was not found to have a significant effect on repeat purchasing.

Elasticities

It is also useful to evaluate selected results in terms of elasticities. This is particularly true for our questions related to customer acquisition and repeat buying rates. Table 6 reports elasticity measures for order incidence and expenditures for new and existing customers. The order incidence elasticities reveal that customer acquisition is significantly more sensitive to the order size penalties. In terms of response to price and the base shipping level, we have only directional evidence that customer acquisition is less sensitive to the level of shipping charges than repeat buying while customer acquisition is more sensitive to merchandise prices.

The same results pattern holds for the order size elasticities. Repeat buyers are more responsive to the base shipping level while new customers are more responsive to the incentive or penalty structure built into the shipping menu. The greater effect of size incentives on new customer acquisition rates and new customer order sizes may be due to self selection. In addition to the nonlinear pricing aspects of the shipping fee schedules altering marginal behavior, the size incentive structures may fundamentally change the types of customers who are attracted.

An additional analysis comparing the response to a $1 increase in shipping fees relative to a $1 change in basket price was also conducted.[6] This analysis is conducted relative to a base shipping policy that charges $5 to ship an order less than $50, $7 to ship an order of between $50 and $74, and $9 to ship an order containing at least $75 worth of merchandise. In terms of order incidence, the $1 increase in shipping fees is predicted to reduce order volume by 6.2 percent while the $1 increase in basket price reduces order volume by 2.7 percent. These results suggest that in contrast to the laboratory results from Morwitz et al. (1998), the heightened attention to shipping fees causes shipping surcharges to be overly weighted.

Discussion

The growth of Internet-based commerce has increased the attention paid to shipping fees and other fulfillment issues. Researchers have examined how fulfillment affects customer satisfaction (Trocchia and Janda 2003), return behavior (Hess and Mayhew 1997; Hess et al. 1996; Wood 2001), and firm profits (Sawhney 1999, Pyke et al. 2001). Laboratory research has also focused on how consumers evaluate partitioned prices such as shipping fees (Morwitz et al. 1998). Our findings add to the literature by highlighting the relationship between shipping fee structure and order incidence, customer acquisition, and order size.

[6] This analysis is not conducted in terms of elasticities because of the differences in the magnitude of the total prices. Specifically, while a 1 percent change in shipping fees results in an incremental expense of 5 cents on a $5 shipping charge, a 1 percent increase in merchandise prices would have a 50 cent impact on a basket of $50 worth of merchandise.

Table 7
Consumer demand contribution analysis

	Graduated fees ($5, $7, $9)	Free shipping ($0, $0, $0)	Free large ($5, $7, $0)
Orders	153.5	225.6	188.9
New customers	93.01	121.3	111.3
Repeat buyers	60.54	104.3	73.5
Average order size ($)	51.32	47.47	64.22
Shipping subsidy ($)	1.75	7.32	5.84
Contribution per order[a] ($)	11.08	4.57	10.21
Total contribution ($)	1700.88	1031.87	1888.21

[a] Assumes a gross margin of 25 percent on merchandise, which is approximately the firm's average gross margin.

The evidence suggests that higher shipping fees reduce store traffic and that order size incentives (penalties) result in larger (reduced) order sizes. We also find important differences in the responsiveness of existing and prospective customers. Customer acquisition, likely through a self-selection process, is especially sensitive to size penalties in terms of both incidence and amount. Conversely, existing customers are more sensitive to the base shipping fee level. These results are salient for firms interested in balancing acquisition and retention efforts.

Interrelated equations make it possible to evaluate the overall impact of a variety of shipping fee schedules that may have conflicting effects on different managerial goals. Table 7 illustrates these tradeoffs by using the estimated equations to forecast the overall effects of three alternative shipping policies on customer demand. The policies include a "Graduated Fees" structure in which shipping fees increase as order size increases, a "Free Shipping" promotion, and a "Free Large" schedule that waives fees for the large order category. Each policy possesses weaknesses and strengths along with various dimensions of interest. The "Graduated Fees" policy minimizes the shipping subsidy and results in the most profitable orders. The "Free Shipping" policy results in the highest overall order incidence and is the most effective policy in terms of customer acquisition. The "Free Large" policy results in the largest order sizes and the highest total daily contribution. Conversely, each policy is outperformed by others along certain dimensions. For instance, the "Graduated Fees" policy attracts relatively few new customers while "Free Shipping" involves large subsidies and yields a small average order size.

It should be noted that the preceding analysis is limited to assessing the immediate contribution provided by customer revenues. As such it does not fully address dynamic considerations related to customer acquisition and potentially important operational costs. In general, the formulation of the shipping fee structure for a given firm should consider the relative costs of customer acquisition and retention as well as the economics of the firm's logistic system. Retailers with low cost customer acquisition instruments may benefit from avoiding "Free Shipping" promotions or otherwise heavily subsidizing shipping. In terms of operational costs,

order size incentives may be appropriate for firms attempting to manage demand to achieve logistics efficiencies. For example, if a picking and assembly system is designed to be more efficient for certain order sizes, it may be advisable to use quantity incentives to manage the distribution of order sizes. Similarly, if a logistics system is designed for a certain level of demand (number of orders), then higher or lower shipping fees may be a powerful instrument for managing order incidence rates. In sum, the determination of the appropriate shipping fee structure involves a multi-dimensional balancing act that should consider consumer demand, customer base growth and operational costs.

To our knowledge, our analysis is the first to systematically study the impact of shipping fees on order size, order incidence, and customer acquisition. The empirical research focused on the larger issue of store traffic is also fairly limited (Walters and MacKenzie 1988; Lam et al. 2001). As such, there are many opportunities for additional research. For example, while the variations in shipping fees in our data provide an opportunity to study customer reaction to these fees, our data are sourced from a single firm in the grocery category. Replications with data from different categories would help strengthen the generality of the findings.

The examination of data from alternative categories may also be useful for identifying the role of previous category experience. Our data are from a category in which consumers have historically absorbed many of the costs associated with order assembly and transportation. Because these costs of time and effort are not explicit, it may be that the reference price for grocery delivery may be relatively low. In categories such as clothing with a long history of catalogs that charge for shipping, the category reference point may be fairly different. An open research question is therefore how sensitivity to S&H fees may vary according to category.

In terms of model specifications, there are two issues that merit future research. First, our investigation of shipping fee reference effects was fairly inconclusive. The multicollinearity in the fees made it difficult to identify reference effects. It would be useful to experimentally test a shipping fee change that was explicitly designed to capture reference effects. It should also be noted that the variation in the primary price variable is mostly driven by weekly promotional activity. Systematic tests of varying regular prices and weekly promotional activity would also be useful for investigating the impact of different components of total price.

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