A Microeconometric Analysis of Consumer Response to Direct Marketing and Mail Order

Thesis by

Gretchen A. Kalsow

In Partial Fulfillment of the Requirements

for the Degree of

Doctor of Philosophy

California Institute of Technology

Pasadena, California

1997

(Submitted May 29, 1997)

Acknowledgements

Most importantly I'd like to thank Glenn Habern, former Chief Information Officer for Fingerhut, Inc., and Rachel O'Brien, Vice President for Customer Service at Fingerhut, Inc. They provided encouragement and access to the data. I also appreciate the assistance from Deb Campbell and Linda Drake in Randy Erdahl's group (corporate marketing research) in extracting and transmitting customer profiles, orders, and promotion details. In addition, Bruce Crownhart and Todd Miller extracted product related data and Ray DeZuirk and Craig Nelson extracted promotion data. I appreciate their effort and dedication to extracting and transmitting the data to Caltech.

I also appreciate the assistance I've received from my advisor, Jeffrey A. Dubin, and the helpful comments and encouragement of Scott E. Page, D. Roderick Kiewiet, and David M. Grether.

Last, I'd like to thank my family and friends for having the patience to see me through this!

Abstract

This dissertation builds a series of micro-econometric models of consumer response to direct marketing and mail order. It employs a unique dataset from one of the largest mail order firms in the United States. Prior to building the models a brief history of the mail order industry is included to alert the reader to level and type of information that has been amassed over the last century. The next chapter compares the linear probability models commonly in use in the direct marketing industry to logit discrete choice models. Following that analysis is an implementation of the Dubin and McFadden [11] discrete/continuous model. It supports the hypothesis that the decision to purchase and the purchase amount are correlated, which indicates that the independent regressions for the propensity to purchase and the purchase amount currently being used by direct marketing firms could be improved upon.

The following chapters build and estimate three discrete time/discrete choice discrete/continuous models. The first model is one in which each time period is independent of the other time periods. The second model assumes that each individual has a reservation value, or pain threshold, for ordering products. The last model is a nested logit model in which future periods, i.e., consumer's expectations, are considered when making their purchase decision.

An appendix describing the data and the process for building the dataset is included at the end. In addition, a second appendix containing an outline of potential

future research closes out the dissertation. The third appendix contains a proof of one of the propositions.

Contents

List of Figures

List of Tables

Chapter 1 Introduction

1.1 What is Direct Marketing?

Kotler estimates that non-store retailing accounts for 12% of consumer purchases [31, page 567], and is increasing faster than retail store sales. Non-store retailing can be divided into four categories: direct selling,[1] direct marketing, automatic vending, and buying services. Direct marketing includes mail order catalogs, direct mail (letters, flyers, foldouts, etc.), telemarketing, television marketing/infomercials, and the Internet.

Direct marketing may be either the primary or the secondary channel of distribution for any given business. For example, while many specialty and department stores derive the majority of their sales from retail locations, they also sell through catalogs. Catalog showrooms, on the other hand, may attribute most of their sales to the catalog, and a lesser amount to the showroom. Other catalog companies operate factory outlets for overruns or seconds, while others operate solely through mail order catalogs.

Direct marketing firms differ in as many dimensions as retail stores differ from each other; their delivery mechanism(s) and promotional tools, product offer structures, target markets, and types of customers cover the gamut. The size and number of

[1] Direct selling includes one-to-one selling, party selling, and multilevel marketing. See Kotler (1997) for additional information.

promotions (e.g., catalogs) vary from 2000-page catalogs issued twice per year to hundreds of single-offer promotions sent out per year. The offers can be for single items or products, or for multiples or "kits."[2] The target market also is not limited to consumers – many business-to-business direct marketing firms exist.

Direct marketing in an industrial setting differs from the consumer market in many of the same ways that retail store marketing efforts differ. First, industrial orders tend to have larger dollar values than consumer purchases, supporting different levels and types of marketing efforts for the same profit. Second, the cost of changing suppliers for a business is frequently higher than it would be for an individual consumer, which may lead to supplier loyalty. Finally, the delivery and F.O.B. (free on board) terms can differ – few consumers backhaul their goods from the retailer!

On the consumer side of direct marketing, the orders are typically for smaller dollar values and loyalty varies widely among firms and consumers. Some of the largest users of consumer direct marketing include financial institutions (credit cards, lines of credit, etc.), airlines and travel agencies, and insurance companies. In addition, the mail order companies and retail store chains employ various forms of direct marketing.

1.1.1 Current Retail Trends

As recently as the last decade, the imminent demise of the mail order industry was forecast [30]. However, technological advances in both business data processing and

[2] A multiple offer would be either a case or multi-pack item. A "kit" is usually a group of similar or complementary items sold as a single unit. For example, a camera, the case, tripod, wide-angle lens, and two rolls of film may constitute a kit and would be tracked under a single product code. In addition, the camera may be sold independently using a different product code.

home computers have created a new environment for the industry. The implementation of existing technologies and development of future ones is sure to impact this industry. This section is a brief overview of trends in retailing that affect direct marketing firms, including the use of information and new technologies.

With increasing accuracy, both retail stores and non-store retailers can track their profitability by product. This leads to discontinuing lines of business (e.g., the general merchandise Sears catalog), specialization (e.g., creation of home furnishings and appliance centers from the department store chains), and even leasing space within their store to other vendors (visit the local Montgomery Ward or K-Mart). In addition, through the use of computers that manage the printing of catalogs, business can more easily create specialized catalogs to target specific audiences. This technological advance in printing has reduced the cost in terms of printing and in tracking performance results when many versions or editions of a catalog are to be created.

Technology has enabled multiple user interfaces. Automated dialing for outbound telemarketing, home shopping channels, infomercials, marketing on the Internet, are a few examples. Laser disk catalogs may have flopped, but the potential for marketing through the Internet is unknown.

The availability of extensive marketing databases is increasing, and the accuracy, timeliness, and completeness of their contents is improving. These large databases assist the firm in making both aggregate and individual level decisions. At the aggregate level the data may be employed to determine the number and characteristics of various versions or editions of a particular promotion. In addition, the quality of

the data may dictate the number and accuracy of market tests that are required for a promotion.

At the individual level, information contained in a marketing database not only helps determine which offers are received by a potential customer, but also the "flavor" of those offers. For example, in industries such as banking and insurance, offers with different attributes (e.g., credit card limits, interest rates, premiums, etc.) may be made through direct marketing offers. Mail order firms offer recent purchasers of electronics corresponding warranty and service options, or cabinets for their new television or stereo. In addition, firms track the time of day a customer places an inbound call to maximize the probability that the customer will be home when they place their outbound telemarketing call.

In general, both store and non-store retail markets are affected by the extension of credit to one's customers. The increased availability of information may have reduced the transaction cost and risk of bad debt, but it may not be less expensive than using a national credit card. This aspect of credit granting is vital to the company examined in this dissertation – their customers use the firm's credit services through the use of a "rent to own" type of purchase agreement. These customers are frequently considered high credit risks by traditional financial institutions. However, in the recent past, secured credit cards and other offers such as a K-Mart credit card [60] or a Wal-Mart credit card have made other credit options available to this group of consumers. An important difference between the firm employed in this dissertation and the new competitors in this credit market is the availability of information – the firm studied

has kept information on high risk individuals and their purchase/payment patterns for over thirty years.

In addition to the increase in non-store retailing, Kotler [31] identifies several other trends in retailing that affect both store and non-store retail firms. These include new retail forms, shorter life cycles, increasing intertype competition, polarity of retailing, growth of giant retailers, vertical marketing systems, using a portfolio approach, continued increase in the importance of retail technology, and global expansion. Direct marketing firms, in particular mail order companies, are poised to take advantage of the trends identified by Kotler. Whereas a retail store would require a new name and additional floor space to offer a specialty store, a mail order company prints another catalog and works on acquiring a names list, which can be accomplished in a shorter time frame than those changes requiring physical or infrastructure changes within the firm.

1.2 Current Issues in Mail Order and Direct Mail

1.2.1 Marketing Issues

Customers are the vital component in direct marketing and, as such, identifying potential customers and various customer types (e.g., holiday only, one-time only, occasional, and core buyers) is central to the success of many direct marketing firms. Concerns specific to direct marketing firms are: customer retention [36], and departures [21], consumers' attitudes toward direct mail [42] and the process of converting

consumers into customers [51]. Direct marketers are in the process of expanding their consumer analysis to areas traditionally considered by store retailers, such as complaining customers [18], loyalty and the effects of advertising [49].

Direct marketers are also watching the changing demographics of the nation. Pashigian and Bowen [47] found that an increase in the relative cost of women's time has contributed to the growth of national brands and the reduction of some retail services. In addition, this relative cost increase was also related to an increase in male shopping, a trend sure to affect direct marketers as well as retail stores. Braun [7] studied both shoppers and non-catalog shoppers, finding differences in both their demographics and their shopping attitudes and preferences. Marketers, including direct marketing firms, will continue to investigate the differences presented in Braun's study as a basis for further segmentation.

Recent studies [8] have found that television advertising clutter may not impact one's memory in terms of the ability to remember an advertised product over the time. However, Johnson and Cobb-Walgren [26] found that clutter affects older viewers negatively to a greater extent than younger viewers. In light of this, as the population ages, the "clutter" placed in a potential customer's mailbox, electronic or otherwise, related to future direct marketing offers, is a concern to direct marketing firms. In addition, the idea of mail stream management and how it relates to customer saturation is currently being studied by several large mail order firms.

1.2.2 Management Issues

Of general management concern are the growth of the direct marketing industry and its sustainability and the trend toward merchandise specialization. Management faces several important issues related to the cost structure of the direct marketing industry, including customer acquisition, inventory, publishing and postage, and wage scales.

The cost of acquiring and retaining a customer is a significant issue for direct marketers, especially when combined with the trend to specialize. Some large direct marketing and mail order firms are specializing by creating multiple "companies" within their corporate structure, each with its own image and set of target customers. The customer name can be rented by one company but not necessarily used by other companies within the corporate structure without an additional fee.

A major cost for direct marketers of physical products is the cost of inventory, including labor, interest charges, and physical warehouse space. Fischer and Byers [15] highlight potential direct labor cost reductions by improvements in a mail order business's inventory and order processing systems. It should be noted that significant cost savings are also realized in improved inventory management and administration.

A second major cost, the cost of bulk paper and printing, has risen dramatically in the last five years [16]. The U.S. Postal Service is offering "maximum discounts for maximum preparation," creating incentives for direct marketers to sort and bundle their outgoing mail appropriately.[3]

On a broader level, management must watch the growth of the service sector as

[3]See, for example, the advertisement appearing in the May 31, 1996, *New York Times*, Section C. from the United States Postal Service.

it relates to employment [3] [46]. Many direct marketers and mail order companies are distributors, not manufacturers, and as such compete for low-skilled employees with others in the service sector. In addition, retailing in general is one of the largest employment sectors in the U.S. labor market [59]. As technology improves and is disseminated throughout additional levels of direct marketing organizations, the need for more highly skilled workers will increase, with the potential to change the wage structure within the industry.

1.2.3 Court-Mandated Issues

Two significant court mandated rulings affecting mail order and direct marketing are the privacy issue and collection of sales and/or use taxes. Direct marketers earn their profits by managing information about individuals both for their own use and for "resale" purposes. Twenty years ago, the courts gave individuals the right to be removed from specific mailing lists and from all mailing lists of firms associated with the Direct Marketing Association. If an individual wishes to be eliminated from the list, the firm cannot resell their name and the solicitation of any future business is punishable by fines.

The other significant issue direct marketers face is that of taxes – sales and use taxes. Although courts have upheld the *Bellas Hess* decision that mail order companies are not required to collect sales taxes for states in which they have no physical nexus, changes in the market place, including increasing mail order sales volumes and the use of the Internet, may bring new challenges to the traditional arguments of

the Due Process Clause and the Commerce Clause. For additional information see Cain [9], Gillis [17], Rosen [52], and Snavely [58]. However, on the issue of use taxes, states have won the ability to impose a "direct use tax on the value of the catalogs distributed..." [34]. In addition, states may impose a use tax on consumers purchasing goods from an out-of-state direct marketing firm. For example, the Illinois state income tax form includes a line item for taxes due on the use of items purchased in another state but used in Illinois.

1.3 Firm Background

The company employed in this analysis is one of the largest mail order companies in the United States. They have experience with several forms of direct marketing, including "base business" mail order, infomercials, liquidation of higher-end products, shopping channels, joint ventures, and specialty goods such as jewelry. This dissertation focuses on the base business mail order functions within the firm and its customer base.[4] The company is unique in many aspects. First, they've maintained a database of customer information for over thirty years – amassing vast quantities of data at very detailed levels (every item ordered and every piece of promotional material sent). Second, their target market is the bottom third of the population when measured by annual income. Yet, given this market segment, they are able to pull at a rate three times the industry average (pull rates are response rates). The

[4] Although the practice area of the business this dissertation is concerned with is called "base business", it is not original business of the company. The company started life as a manufacturer of vinyl seat covers in the post-World War II economy.

business is also very successful in "promoting" consumers through the practice areas – nuturing and developing a loyal customer base through various stages (see the next section). In addition, this business is not a small business – their annual revenues consistently place them in the top five catalog firms for the last decade. They are also one of the top direct marketing firms.

1.3.1 Base Business Practice Areas

Within the base business there are "front-end", i.e., untested, and "back-end", or proven, customers. There are several different approaches in direct marketing to test a new customer and move them from the front-end to the back-end. Some firms will send a customer N similar offers before either declaring the customer "good" or dropping their name from the list. Other firms will step a customer through several processes to determine their potential lifetime value. The firm studied employs the second approach. A customer is frequently offered a single item at a low dollar value, with a single payment. The customer is then offered a set of slightly more expensive items with multiple payments, but still limited in number such that the firm's exposure to bad debt is minimal. After several iterations that involve more expensive items and extended terms a customer becomes a back-end customer. Therefore, back-end customers are those who have demonstrated the ability and willingness to pay regular monthly payments over extended periods of time for semi-durable items.[5]

[5]Because the company uses payment plans, items that may be considered disposable, such as sheets and towels, to other segments of the population, should be considered semi-durables for this segment. In general, they probably do not posses the means to replace such items on as frequent a basis as others.

1.3.2 Promotional Practices

The company studied employs various forms of promotion, ranging from solo offers (single product) to multilogs (multiple catalogs, typically shrink wrapped together). "Solos" are used to generate and test front-end customers. The next promotion is called an "8-prod" – an offer of approximately eight products sent in a single envelope. Multi-mailers, or "28-prods," are envelopes with 28 products. Catalogs range in size (number of pages), quality of paper, and number of offers per page. A "typical" catalog is from 80 to 120 pages and is the most frequent form of promotion to back-end customers. Multilogs are multiple catalogs sent in a single package, not necessarily related. For example, there may be a general merchandise catalog, an outdoor catalog, and a jewelry catalog included in a multilog.

1.3.3 Products

The products sold include clothing, soft and hard domestics, jewelry, sporting goods, outdoor equipment, furniture, electronics and toys.[6] Although there are well-known brands, such as Bissell (vacuums and carpet steamers) and Cannon (bed and bath linens), the majority of the products are not branded. The domestics lines include matching sets of everything for the house – from kitchen towels to cannisters to crock-pots to dishes and glasses with motifs such as cows, geese, or bears. Sporting goods and outdoor equipment includes bikes, tents, professional team licensed apparel, and other shippable items. The furniture is frequently drop-shipped from the manufac-

[6]Soft domestics includes items like sheets, towels, and table linens. Hard domestics includes tableware and small applicances.

turer.[7]

1.3.4 Target Customers

The company targets lower income markets not typically served by other mail order companies. The company offers their own credit terms via a rent-to-own agreement. Under these terms the customer receives the product along with a payment booklet. The customer returns a payment coupon with their monthly check. When the last coupon is paid ownership of the item transfers from the company to the customer. For example, a blender may be purchased for $30, plus interest, shipping and handling, for a total of ten payments of $5.50 each. The customer has had possession of the blender during the entire ten months, but ownership does not pass to the customer until the last payment is made.

Various pay plans may be offered for the same item in different catalogs. An average pay plan for a $60 item may range from $7/month for 12 months to $15 for 5 months. Note that by using a rent-to-own format the applicable usury laws allow the company to charge 22 to 26 percent interest.[8] Although the customers are often considered high credit risks, the company's default rate is not abnormal for a

[7]Distributors frequently drop-ship items that are bulky or purchased infrequently to minimize their storage and carrying costs. When an item is drop-shipped, the customer's order is "forwarded" to the manufacturer and shipped directly from the manufacturer to the customer. The customer is billed by the distributor.

[8]The 22-26 percent interest may appear high. In fact, it may appear that the company is taking advantage of the customers. However, it should be remembered that secured credit cards, a recent alternative for this group of customers, often require a non-interest bearing deposit of 50-100% of the credit limit. Therefore the total interest charge in that case is the lost interest on the deposit plus the interest charged for purchases. Another comparison for interest rates is that allowable by pawn shops. In California the maximum interest rate is 255%. Even people filing their tax returns through third party services employing electronic filing frequently "pay" 1% per day to receive their refunds at the time of filing.

single-company or department store credit plan.

An interesting part of this company's business is the use of credit to obtain and retain customers, and also their assistance to the customer when in fiscal crisis. The company will contact the customer and attempt to find a mutually agreeable repayment plan should the customer fall behind. After several attempts to work through the process have failed the customer's interest payments may be reduced or written off. If the customer eventually repays the amount, even after an extended period of time, the company will "reactivate" the customer. However, this intensive, time consuming process produces very loyal customers and generates a significant amount of goodwill through word-of-mouth.

1.4 What's in the Dissertation

This dissertation builds a series of micro-econometric models of consumer response to direct marketing and mail order. It employs a unique dataset from one of the largest mail order firms in the United States. Prior to building the models, a brief history of the mail order industry is included to alert the reader to level and type of information that has been amassed over the last century. The next chapter compares the linear probability models commonly in use in the direct marketing industry to the logit discrete choice models. Following that analysis is an implementation of the Dubin and McFadden [11] discrete/continuous model. It supports the hypothesis that the decision to purchase and the purchase amount are correlated, which indicates that the independent regressions for the propensity to purchase and the purchase amount

currently being used by direct marketing firms could be improved upon.

The following chapters build and estimate three discrete time/discrete choice discrete/continuous models. The first model is one in which each time period is independent of the other time periods. The second model assumes that each individual has a reservation value, or pain threshold, for ordering products. The last model is a nested logit model in which future periods, i.e., their expectations, are considered when a consumer makes their purchase decision.

An appendix describing the data and the process for building the dataset is included at the end. In addition, a brief appendix containing an outline of potential future research closes out the dissertation.

Chapter 2 A Brief History of Mail Order

2.1 The Late Nineteenth Century

The structure of the American retail market for household goods underwent radical change in the post Civil War period. Isolation gave way to railroads which provided relatively quick and inexpensive transportation for both goods and people. In addition, as news and information traveled faster across the ocean and the continent, people's preferences for goods changed such that more sophisticated and fashionable items were in demand.

Immediately following the Civil War, the country merchant frequently possessed monopolistic powers, since the search costs for the farmer were significant both in terms of the direct transportation cost and the loss in productivity. This enabled the merchant to set the price at a healthy markup over his costs in addition to charging the farmer credit for the goods.[1] Although the farmer could, theoretically, bargain with the merchant over the price, the merchant held the position of power by granting credit.

By 1872, Aaron Montgomery Ward determined that selling directly to the end consumer, eliminating wholesalers, jobbers, and retailers, each a middleman taking a profit, could be a profitable business venture. His plan was to obtain quantity

[1] See Latham [35] and Michael [41]. Farmers frequently bought goods on credit employing their next year's crop as payment.

discounts from the manufacturers and pass a portion of the savings on to customers [35]. Although other mail order firms were in business at the time, Ward and his two partners went forward with their plan to become large volume discounters by sending farmer's cooperatives a single page price list. The goods were delivered via railroad and customers were allowed to use C.O.D. as a form of payment.

Sears, Roebuck, & Co. joined the mail order business in 1886 by offering household durable goods. Their strategy was to enter the market for low-end merchandise and offer credit [10]. In 1893 Spiegel switched from cash sale distribution of high-quality furnishings to distribution of low-end household goods for sale using credit [57]. Spiegel experimented with mail order in 1904, joining their successful Chicago competitors, Montgomery Ward & Co., and Sears, Roebuck, & Co. This midwestern rivalry was the stage for the growth of the high volume mail order business.[2]

2.2 Turn of the Century

The turn of the century brought many technological changes to the mail order industry. For example, through advances in photography, printing and publishing, along with changing public standards of "sensibility," the Montgomery Ward catalog went from drawings of clothing in 1874 to live models in halftone photographs in 1896. By this time over 1200 mail order companies were sending catalogs to six million customers [37]. The customers not only demanded more illustrative and colorful cat-

[2]See [35] and [57] for further information on the rivalry and the history of acquisition and merger talks between the firms.

alogs, but they also required more timely catalogs. The semi-annual Sears' catalog helped the company grow faster, ultimately overtaking the annual Montgomery Ward catalog. In addition, seasonal catalogs and those targeted to specific audiences were developed at the turn of the century.

Another important advance that assisted the mail order business was the addition of rural routes. RFD, rural free delivery, was created in 1893 with the first free experimental deliveries in 1896. By 1912, with the majority of people still residing in rural areas, the national parcel post system was created. The ability to easily deliver goods virtually anywhere in the country removed one of the last obstacles to growth at that time [37, pages 184-5]. However, a byproduct of this advance was an unprecedented increase in competition between local country merchants and the mail order houses. Newspapers published cartoons depicting the evil, anonymous catalog companies fighting the local merchant [35]. The newspapers along with the local merchants, whose advertising supported the newspapers, also held contests to collect catalogs – and held public bonfires of entire stacks of catalogs.[3] Complicating the matter was the fact that the local merchant also frequently performed the duties of the postmaster, delivering the catalogs and writing money orders. In response, the mail order companies sent packages in plain brown wrapping – eliminating the return name and address.

A third change was both a blessing and a potential disaster. Sears began selling automobiles as early as 1908, and Montgomery Ward assembled automobiles as early

[3]Refer to [10, page 510] for additional information.

as 1912. The problems associated with lack of service sent Montgomery Ward out of the automobile service within two years. However, the bigger problem was the increased mobility of their customers. By opening their first retail store in 1925 in Chicago, Sears increased their market from primarily rural populations to include those in urban areas [10, page 558]. Montgomery Ward followed by opening a retail store in 1926 that sold tires and batteries, but was effectively a catalog showroom for other product lines. Three years later they had ten department stores and over 200 smaller, detached stores. Thus, the large mail order houses saw an end to their catalog-only marketing strategy.[4] During the same time period World War I created an opportunity for Filene's to open a mail order shopping service. American parents desiring to send a package to their sons at the front could do so through Filene's by 1918 [37, page 98].

A fourth factor was the growing acceptability of installment buying plans. Although the Singer Sewing Machine Company had been using such plans since 1869 [10], as had various piano dealers, the mail order companies had limited their use of installment plans to durables or semi-durables. Spiegel was selling on credit by 1893, but Sears did not bow to the competitive pressure to do so until 1915. However, by 1935 they instituted carrying charges and four years later an "easy payment plan" that extended to non-durables such as shoes and clothing [10, page 527]. Montgomery Ward also extended the types of goods that could be sold on installment in 1930.

[4]Note that Spiegel did not open their first general merchandise retail outlet until after World War II – refer to [57] for additional information. Spiegel had previously switched from a cash retail home furnishings concern to a mail order credit-based company in 1893.

2.3 The Depression Years

The Depression caused many industries to retrench at every level. The mail order companies were no exception.[5] Not only were people spending less, but they were more cost conscious about the goods they purchased, causing modifications in the products offered for sale. The automobile made it feasible for people to travel to the city to shop in department stores. The mail order firms continued expanding their retail operations until immediately prior to the stock market plunge. For example, Montgomery Ward opened 49 stores in 1930, even though sales were down due to a lower average value in catalog and lower volume in retail. The catalog companies deployed various schemes to increase orders, but to no avail – retail stores were closed and catalog layouts reworked.[6]

The largest impact on the mail order houses in the Depression years probably came through technology. Sears followed Montgomery Ward with the use of telephones to receive orders from customers in 1931. The initial telephone orders that were transcribed to order forms were only made possible by the simultaneous liberalization of installment payment plans.

---

[5] Refer to [10] and [35] for additional information on the expansion into retail stores immediately prior to the Depression, and the subsequent effect of the Depression on the businesses.

[6] For example, Montgomery Ward tried instituting a scholarship plan [35, page 78] where students received fifteen cents for every dollar of business they brought in. In retrospect, they determined that the majority were orders for normal customers who would have ordered regardless of the surrounding hype. This failure to achieve additional sales was an expensive method of adding to the mailing list. Refer to [35] for additional ploys that were tried, including one linked to the 1933 Century of Progress Exposition where children received a gift for mailing in their parent's address!

2.4 The 1960's

At the beginning of the 1960's the mail order industry was thought to be "mature."[7] Others placed the mail order industry in a state of demise. However, demographic changes not only averted a complete demise of the industry, but fueled the growth of specific segments. The unprecedented number of women working in a peace-time economy, and hence women who had less time for shopping, may have contributed to the growth in catalog shopping. The other trend was the growth of suburbia and the subsequent explosion of shopping centers and malls.

As a result of these demographic changes, two types of mail order businesses have grown. An increase in all types of specialty stores both at shopping malls and in the catalog business occurred. In 1963 Land's End started their mail order business, evolving from a sports wear catalog to a more general apparel catalog. Upscale retailers such as Neiman Marcus expanded their Christmas catalog into additional mailings to capitalize on their national reputation. Initially, Neiman Marcus simply employed their own list of charge customers as a mailing list, later buying outside lists of potential customers [38, page 228]. Others, such as J. C. Penney, migrated from a "cash and carry" general merchandise department store chain to a major player in the mail order industry.[8]

[7]Refer to Kotler [30]. He states that the period of fastest growth, from 1915 to about 1950, was over and therefore the market was mature.

[8]Refer to [48] for information on J. C. Penney's.

Chapter 3 Linear Probability Models versus Discrete Choice Models

A common procedure for validating the fit of a model in direct marketing is to compare the actual and predicted response rates by decile. The first step in the process is to calibrate a linear probability model using prior event data (i.e., response and customer information from a prior execution of a similar promotion or group of promotions). The linear probability models developed by some direct marketers are based on an *ad hoc* list of dependent variables. This particular company generates a list of five to six hundred variables from a customer profile, including the arc tangent of income, and tests various combinations of the variables to determine the "best" model. This model is then used for scoring (i.e., ranking) customers for similar promotions in the future.

The next step is to apply the model to the current names list and divide the customers into deciles based on their predicted response probabilities. Note that this probability is not restricted to values between zero and one. However, since the item of interest is the decile, as long as the ordering of the customers is correct, the model "fits".[1]

[1] A marketing analyst at the company studied remarked that the estimated revenue from a promotion can be off by a factor of up to twenty. This suggests that simply multiplying the linear probability model's predicted probability by an average purchase amount, the results of two independent processes, is, at best, inexact.

Direct marketing firms frequently assess the fit of their models and determine the mailing list for promotions based on deciles. Assume that the first decile is the most likely to purchase. Then the existing model of purchase propensity is considered a good fit as long as the actual purchase frequency of the first decile is greater than that for the second decile, and so on. At some point, when the actual frequency of purchase for a decile is lower than that for a subsequent decile, the model is replaced with one calibrated using more recent data.

In addition to verifying the fit of their models, some direct marketing firms use deciles for determining the mailing list for a given promotion. A tentative promotion calendar, i.e., sequence and type of promotions, is created as part of the annual budgeting process. Successful prior promotions are repeated, new offerings are added, and less successful promotions are deleted from the calendar. During the budgeting process a percentage of past or estimated future sales is allocated for marketing and promotional materials. These budgets are based on assumptions regarding all steps of the promotion process, from the cost of developing creative materials to the cost of sending a specific number of catalogs for a given promotion. For a given promotion, the estimated number of catalogs included in these preliminary budgets helps determine how many deciles receive the promotion.

McFadden [39] showed that random utility maximization, under certain assumptions, results in a logit model for choice probabilities. The company's marketing analysis group does not employ logit models, firstly because they do not believe the results would differ from their linear probability models, and secondly, using their

statistical software, they were unable to get convergence for a binary choice logit model in 24 hours of mainframe CPU time. The second reason is not an issue and is not addressed in this chapter. However, the first reason is explored in more detail below. The initial sections setup and execute a simulation comparing the linear probability model with a binary choice logit. The next section then executes the same comparison using company data. The following sections correct for the heteroscedasticity introduced into a model with binomial probabilities. Finally, additional areas of investigation related to the debate on linear probabilities versus logit models are discussed.

3.1 Simulation

3.1.1 Set-Up and Execution

A sample dataset consisting of 10,000 observations was created using a dependent variable and two independent variables that were generated from random numbers. The dependent variable was set to "1" for approximately 40% of the observations. The independent variables were generated using:[2]

$$x1 = urnd * 8 + urnd$$

$$x2 = nrnd * 3.5 + urnd.$$

[2] "Urnd" indicates that a random number is generated from the uniform distribution. Similarly, "nrnd" is a random number generated from a standard normal distribution.

A 10% sample of the dataset was selected and both the linear probability model and the binary choice logit model were executed. The process was repeated 1000 times. For every replication the decile in which the observation (i.e., the customer) appeared was saved for each customer.

3.1.2 Results

Refer to the Table below for a summary of the results. The decile ranking for a customer when employing the linear probability model, or regression, is given by the row, and the decile ranking for the same customer in the logit model is given by the column. If the models produced exactly the same ordering then all observations would appear on the diagonal. This appears to be the case in this simulation. However, before continuing it should be noted that in direct marketing a response rate of 1-2% is common. The slightest variation in the list of customers selected for a particular promotion can impact the pull rate dramatically. In fact, the greatest concern is among the customers "in the middle." Those customers with a very high or very low probability of purchasing are fairly easy to distinguish, regardless of the model employed.

Note that this analysis differs from other analyses that compare probit or logits to linear probability models. For example, see Kiewiet [29] for a brief overview of the differences in the predicted probabilities between probit and linear probability models. Rather than focusing on the differences in predicted probabilities, which are greatest at the extremes, this analysis examines the agreement of the ordering of

the individuals that results from an execution of a particular model. For example, in a linear probability model an individual with a high propensity to purchase may have a predicted probability in excess of 1, say 1.5. However, because the logit and probit models restrict the predicted probabilities to lie in the unit interval, the same individual's predicted propensity to purchase might be 0.95 in the discrete choice model. Another individual may have a predicted probability to purchase of 0.3 in the linear model, and 0.4 in the discrete choice model. The "difference" in these probabilities is 0.55 for the first individual, and only 0.10 for the second. It is this difference that other analyses examine. However, in this situation, the important "difference" to consider is the decile ranking of the consumers – the important decision is whether a specific individual should receive a particular promotion or not.

Table 3.1: Comparison of Decile Rankings in OLS and Logit - Simulation

Counts and Percentages

Regression Decile	Logit Decile 1	2	3	4	5	6	7	8	9	10	Total
1	99416	52	0	0	0	0	0	0	0	0	99468
	99.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
2	52	99856	65	0	0	0	0	0	0	0	99973
	0.1	99.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
3	0	65	99735	67	0	0	0	0	0	0	99867
	0.0	0.1	99.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	10.0
4	0	0	67	99845	71	0	0	0	0	0	99983
	0.0	0.0	0.1	99.9	0.1	0.0	0.0	0.0	0.0	0.0	10.0
5	0	0	0	71	99935	69	0	0	0	0	100075
	0.0	0.0	0.0	0.1	99.9	0.1	0.0	0.0	0.0	0.0	10.0
6	0	0	0	0	69	99607	81	0	0	0	99757
	0.0	0.0	0.0	0.0	0.1	99.8	0.1	0.0	0.0	0.0	10.0
7	0	0	0	0	0	81	99737	77	0	0	99895
	0.0	0.0	0.0	0.0	0.0	0.1	99.8	0.1	0.0	0.0	10.0
8	0	0	0	0	0	0	77	99801	77	0	99955
	0.0	0.0	0.0	0.0	0.0	0.0	0.1	99.8	0.1	0.0	10.0
9	0	0	0	0	0	0	0	77	99765	43	99885
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	99.9	0.0	10.0
10	0	0	0	0	0	0	0	0	43	100332	100375
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	10.0
Total	99468	99973	99867	99983	100075	99757	99895	99955	99885	100375	999233
	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	100.0

3.2 Company Data

3.2.1 Set-Up

The physical quarter database for the selected customers was employed in this analysis. A random group of customers was selected from the original company extract. each with from one to nine quarters of data. The physical quarter database is created by "stacking" each quarter of data for each customer, for every quarter possible.[3] The dependent variable in this case represents the dichotomous decision of whether the customer purchased from the company in that quarter. The independent variables employed were the same as those listed with the discrete/continuous models.

The physical quarter database contains approximately 75,000 observations. For simplicity in testing the models the observations were assumed to be independent. A 10% sample was drawn from the database for execution. The process was replicated 100 times.

3.2.2 Results

The Table below indicates that the linear probability and logit models agree on customer rankings for over 75% of the observations. With higher decile rankings, and therefore higher probabilities of purchase, the two models appear to "agree" more frequently.

For comparison, let's assume that the top 40% of the customers will receive a

[3]Refer to Appendix A for additional information on the creation of the database. Quarters when a customer is not promotable or is simply not yet a customer are excluded from the sample.

particular promotion – a total of 299,594 (40assume that the average pull rate is 2%. This implies that approximately 6,000 purchases will be made (2receive the catalog regardless of which model is chosen (approximately 281,500 customers appear in the top 4 deciles regardless of which model is selected). However, it should also be noted that the remaining 18,000 customers receiving the promotion differ between the two models – three times the average number of orders placed![4] Therefore, the apparent 75% "agreement" of two models may actually be very significant, depending on the behavior of the 36,000 customers (18,000 who receive the promotion if the linear probability model is used, and the 18,000 who receive the promotion if the logit model is used).

There are several reasons the this apparent discrepancy between the linear probability model and the logit model. The next section will discuss how to modify the simulation dataset such that it "behaves" similar to the company data.

[4]The identity of the remaining 18,000 customers depends on which model is selected. They are the remainder of the top 40% of each model. For example, if the linear probability model is selected, then the 18,000 customers are those that are in the top 40% of the linear probability model but not in the top 40% of the logit model.

Table 3.2: Comparison of Decile Rankings in OLS and Logit – Data

Counts and Percentages

Regression Decile	Logit Decile 1	2	3	4	5	6	7	8	9	10	Total
1	57430	14637	0	0	0	0	0	0	0	2777	74844
	76.7	19.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	10.0
2	961	58269	15657	0	0	0	0	0	0	1	74888
	1.3	77.8	20.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
3	2	1977	57051	15858	1	0	0	0	0	0	74889
	0.0	2.6	76.2	21.2	0.0	0.0	0.0	0.0	0.0	0.0	10.0
4	1	4	2179	56695	16006	5	0	0	0	0	74890
	0.0	0.0	2.9	75.7	21.4	0.0	0.0	0.0	0.0	0.0	10.0
5	0	1	2	2334	56632	15937	2	1	0	0	74909
	0.0	0.0	0.0	3.1	75.6	21.3	0.0	0.0	0.0	0.0	10.0
6	0	0	0	3	2266	57279	15310	3	2	0	74863
	0.0	0.0	0.0	0.0	3.0	76.5	20.4	0.0	0.0	0.0	10.0
7	0	0	0	0	4	1640	59003	14236	2	0	74885
	0.0	0.0	0.0	0.0	0.0	2.2	78.8	19.0	0.0	0.0	10.0
8	0	0	0	0	0	2	570	60542	13777	3	74894
	0.0	0.0	0.0	0.0	0.0	0.0	0.8	80.8	18.4	0.0	10.0
9	0	0	0	0	0	0	0	112	61100	13671	74883
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	81.6	18.2	10.0
10	16450	0	0	0	0	0	0	0	2	58480	74932
	22.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.0	10.0
TOTAL	74844	74888	74889	74890	74909	74863	74885	74894	74883	74932	748877
	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	100.0

3.3 Modifying the Simulation Dataset

3.3.1 Set-Up and Execution

The generation of the independent variables was modified such that:[5]

$$x1 = urnd * 8 + urnd \tag{3.1}$$

$$x2 = nrnd * 200/obsno^2 + urnd. \tag{3.2}$$

The execution of the test remained the same – a 10% sample of the 10,000 observations was replicated 1000 times.

3.3.2 Results

First, note that overall the "agreement" of the two models, as indicated by the number of observations on the diagonal, is much lower than that in the original simulation. Second, the first and last deciles are in much higher agreement than those in between, suggesting that it is easier to identify individuals at the extremes with low and high probabilities of purchase.

There are at least two areas a direct marketing analyst should investigate. First, the cause of the discrepancies between the linear probability model and the logit model should be examined. The next section discusses one type of correction for heteroscedasticity due to differences in the underlying probability of purchase for each customer. Second, the "fit" concept should be explored in more detail. See the

[5] "Obsno" refers to the observation number, or row, in the database.

last section of this chapter for further discussion on this point.

Table 3.3: Comparison of Decile Rankings in OLS and Logit – Modified Simulation

Counts and Percentages

Regression Decile	Logit Decile 1	2	3	4	5	6	7	8	9	10	Total
1	96751	2333	286	59	12	1	0	0	0	26	99468
	97.3	2.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	10.0
2	2385	93194	3406	600	251	93	38	4	2	0	99973
	2.4	93.2	3.4	0.6	0.3	0.1	0.0	0.0	0.0	0.0	10.0
3	252	3435	91217	3632	754	343	170	50	14	0	99867
	0.3	3.4	91.3	3.6	0.8	0.3	0.2	0.1	0.0	0.0	10.0
4	65	634	3644	90516	3818	792	324	148	41	1	99983
	0.1	0.6	3.6	90.5	3.8	0.8	0.3	0.1	0.0	0.0	10.0
5	8	231	775	3813	90234	3741	785	370	115	3	100075
	0.0	0.2	0.8	3.8	90.2	3.8	0.8	0.4	0.1	0.0	10.0
6	0	97	327	790	3748	90023	3768	763	232	9	99757
	0.0	0.1	0.3	0.8	3.7	90.2	3.8	0.8	0.2	0.0	10.0
7	0	43	156	366	805	3724	90485	3623	644	49	99895
	0.0	0.0	0.2	0.4	0.8	3.7	90.6	3.6	0.6	0.0	10.0
8	0	5	53	174	361	780	3619	91440	3303	220	99955
	0.0	0.0	0.1	0.2	0.4	0.8	3.6	91.5	3.3	0.2	10.0
9	0	1	3	32	90	246	647	3297	93240	2329	99885
	0.0	0.0	0.0	0.0	0.1	0.2	0.6	3.3	93.3	2.3	10.0
10	7	0	0	1	2	14	59	260	2294	97738	100375
	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	2.3	97.4	10.0
TOTAL	99468	99973	99867	99983	100075	99757	99895	99955	99885	100375	999233
	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	100.0

3.4 Correcting for Differences in Underlying Probability of Purchase – Simulation

3.4.1 Set-Up and Execution

The same simulation data as the last section was employed in this analysis. The execution required two executions of the linear probability model. The predicted probability from the first regression, $\hat{p}$, is used as input to compute the weight for the second regression. The binomial distribution has a variance of $p * (1 - p)$; therefore the weight for correcting the linear probability model, based on differences in the underlying probability of purchase, is $1/(p * (1 - p))^{(.5)}$. The predicted probability from the first regression, $\hat{p}$, is used as an unbiased estimate for p for the weight in the second regression (weighted least squares).

3.4.2 Results

Although the results of this comparison are not dramatically different from those in the prior section (modified data but without using WLS), it should be remembered that the simulation only includes three explanatory variables (a constant, plus $x1$ and $x2$). As expected when employing randomly generated data, these variables typically are not significant in the regressions and logits. The regressions have very low R^2 statistics and the logits are characterized by a percent correctly predicted that does not differ from assuming the majority position, i.e., "no buy."

The next step is to apply the weighted least squares method, correcting for differ-

ences in the underlying probability of purchasing, to the company data. The results of that process are presented in the next section.

Table 3.4: Comparison of Decile Rankings in WLS and Logit – Modified Simulation

Counts and Percentages

Regression Decile	Logit Decile 1	2	3	4	5	6	7	8	9	10	Total
1	95702	3192	398	103	35	8	4	0	0	26	99468
	96.2	3.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	10.0
2	3205	90964	4393	814	347	152	71	19	8	0	99973
	3.2	91.0	4.4	0.8	0.3	0.2	0.1	0.0	0.0	0.0	10.0
3	366	4412	88723	4578	1016	461	218	64	28	1	99867
	0.4	4.4	88.8	4.6	1.0	0.5	0.2	0.1	0.0	0.0	10.0
4	106	858	4542	87963	4696	1076	432	235	73	2	99983
	0.1	0.9	4.5	88.0	4.7	1.1	0.4	0.2	0.1	0.0	10.0
5	34	318	1050	4634	87620	4689	1104	474	148	4	100075
	0.0	0.3	1.1	4.6	87.6	4.7	1.1	0.5	0.1	0.0	10.0
6	1	137	445	1090	4642	87350	4698	1058	311	25	99757
	0.0	0.1	0.4	1.1	4.6	87.6	4.7	1.1	0.3	0.0	10.0
7	0	63	217	484	1073	4626	87823	4638	877	94	99895
	0.0	0.1	0.2	0.5	1.1	4.6	87.9	4.6	0.9	0.1	10.0
8	0	26	75	247	495	1015	4627	88796	4345	329	99955
	0.0	0.0	0.1	0.2	0.5	1.0	4.6	88.8	4.4	0.3	10.0
9	0	3	24	68	138	349	812	4319	90945	3227	99885
	0.0	0.0	0.0	0.1	0.1	0.3	0.8	4.3	91.0	3.2	10.0
10	54	0	0	2	13	31	106	352	3150	96667	100375
	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.4	3.2	96.3	10.0
Total	99468	99973	99867	99983	100075	99757	99895	99955	99885	100375	999233
	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	100.0

3.5 Correcting for Differences in Underlying Probability of Purchase – Data

3.5.1 Set-Up and Execution

The same procedure as that used with the simulation data was followed for the company data. The predicted probability of purchase from the initial regression, $\hat{p}$, was used as an estimate for p in computing the weight for weighted least squares.

3.5.2 Results

It's obvious from the Table below that the weighted least squares method and the logit model do not produce the same decile rankings when employing the company data. However, that is not to say that either model is incorrect. We should still consider the possibility that the explanatory power of the independent variables, being very low, could have an impact that differs between the two models. Another possibility is that comparing deciles is not the correct comparison between the models. Still another possibility is that restricting the coefficients to be the same for all observations is a problem for this type of binomial data. The next section discusses options for continuing this research.

Table 3.5: Comparison of Decile Rankings in WLS and Logit - Data

Counts and Percentages

Regression Decile	Logit Decile 1	2	3	4	5	6	7	8	9	10	Total
1	12723	10745	8617	7226	6174	5463	4876	4527	4812	9681	74844
	17.0	14.3	11.5	9.6	8.2	7.3	6.5	6.0	6.4	12.9	10.0
2	10188	12147	11256	9619	8325	7038	6055	4694	3342	2224	74888
	13.6	16.2	15.0	12.8	11.1	9.4	8.1	6.3	4.5	3.0	10.0
3	7444	9499	10828	10640	9274	8101	6771	5562	4167	2603	74889
	9.9	12.7	14.5	14.2	12.4	10.8	9.0	7.4	5.6	3.5	10.0
4	5470	7368	8946	10178	10394	9231	7921	6773	5454	3155	74890
	7.3	9.8	11.9	13.6	13.9	12.3	10.6	9.0	7.3	4.2	10.0
5	3981	5803	7117	8592	10264	10507	9297	8274	6815	4259	74909
	5.3	7.7	9.5	11.5	13.7	14.0	12.4	11.0	9.1	5.7	10.0
6	2511	3991	5430	6822	8497	10667	11352	10347	9263	5983	74863
	3.4	5.3	7.3	9.1	11.3	14.2	15.2	13.8	12.4	8.0	10.0
7	1364	2349	3402	4649	6296	8580	12183	13240	12817	10005	74885
	1.8	3.1	4.5	6.2	8.4	11.5	16.3	17.7	17.1	13.4	10.0
8	2784	2643	2866	3357	4202	5609	8096	13199	16261	15877	74894
	3.7	3.5	3.8	4.5	5.6	7.5	10.8	17.6	21.7	21.2	10.0
9	11235	8150	6844	5760	4935	4297	4219	5118	9701	14624	74883
	15.0	10.9	9.1	7.7	6.6	5.7	5.6	6.8	13.0	19.5	10.0
10	17144	12193	9583	8047	6548	5370	4115	3160	2251	6521	74932
	22.9	16.3	12.8	10.7	8.7	7.2	5.5	4.2	3.0	8.7	10.0
Total	74844	74888	74889	74890	74909	74863	74885	74894	74883	74932	748877
	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	100.0

3.6 Future Research

There are two areas which require additional research. First, it could be that comparing deciles, although commonly used in direct marketing, is not the best method of comparison between two models. Alternatives to comparing deciles include performing a χ-square test for each model. For example, computing the χ-square statistic for the logit model, the linear probability model, and the weighted linear probability model. Then the results of each model could be compared against a predetermined significance level. Another approach for comparing the results of the three models would be to compare the empirical cumulative distribution functions. In addition, a comparison of the false negatives and false positives for each model should be considered. The model with the fewest false negatives might be considered the "best" if the cost of printing and postage for each promotion is small. However, if the cost of mailing a potential customer a promotion is high, the model with the fewest false positives, *ceteris paribus*, might be considered the "best."

Secondly, models with less restrictive assumptions on the variance, allowing for various forms of heteroscedasticity, should be considered for the linear probability model. Error component models with components for both the cross-section and the time period have been employed in the analysis of demand for other products. Random coefficients models, such as Hildreth and Houck [24], can also be used in the analysis of response to direct marketing. Note that the assumption in Hildreth and Houck, i.e., that the stochastic elements of the coefficients are not correlated between coefficients, may be challenged. However, the model is relatively straightforward to

estimate. First, OLS is executed and the resulting residuals are squared. Next, the squared residuals are regressed on M^2X^2, where X^2 is a matrix with all elements of X squared, and M^2 is the result of squaring the elements of the matrix $M = I - X*(X'*X)^{(-1)}X'$. The result of this regression is an estimate for α, the diagonal components of the variance matrix for the stochastic variables which determine the coefficient vectors for members of the cross-section. The estimates for α can be used to obtain an estimate of the variance of the disturbance vector for the original model. Once the estimate of this variance is computed, it is used in a GLS estimation procedure to estimate the coefficients of the original model.

Chapter 4 Discrete/Continuous Model of Purchase Behavior

4.1 Introduction

This chapter builds a discrete/continuous model of mail order demand.[1] Consumers are categorized as frequent buyers, infrequent buyers, those who fall behind in their payments, and those who choose not to purchase in a given time period. This model uses data from a specific period (December 1993), and estimates the dollar amount purchased given the consumer's classification.[2] The results of the preliminary estimation for this chapter indicate that there is a statistically significant bias present in the predicted amount purchased. The bias occurs because there is an unobserved but measurable correlation in purchase intentions and amounts purchased. The extant marketing research literature typically estimates the propensity to purchase and the amount purchased independently.

[1] Refer to Dubin and McFadden (1984).
[2] Refer to the Data Appendix for additional information regarding the variables.

4.2 Discrete/Continuous Model of Mail Order Demand

In the general case, the probability that choice i is selected from the set of choices J is:

$$\begin{aligned} \mathrm{P}_i &= \mathrm{Prob}\{(\epsilon_1, \ldots, \epsilon_J) : \\ &\qquad U(i, X, \epsilon_i) > U(j, X, \epsilon_j) \; for \; j \neq i\}. \end{aligned}$$

Now let $U(i, X, \epsilon_i) = V(i, X) + \epsilon_i$. Then under the assumption that the ϵ_i are independent extreme value distributed:

$$\mathrm{P}_i = \frac{e^{V(i,X)}}{\sum_{j \in J} e^{V(j,X)}}. \tag{4.1}$$

Let $V(i, X) = X\beta_i$. Then:

$$\mathrm{P}_i = \frac{e^{X\beta_i}}{\sum_{j \in J} e^{X\beta_j}}. \tag{4.2}$$

In the case of three alternatives the probabilities can be expressed as:

$$P_1 = \frac{e^{X\beta_1}}{e^{X\beta_1} + e^{X\beta_2} + e^{X\beta_3}}$$

$$P_2 = \frac{e^{X\beta_2}}{e^{X\beta_1} + e^{X\beta_2} + e^{X\beta_3}}$$

$$P_3 = \frac{e^{X\beta_3}}{e^{X\beta_1} + e^{X\beta_2} + e^{X\beta_3}}.$$

Therefore, the Ratio of the Logs is:

$$\ln\frac{P_2}{P_1} = X(\beta_2 - \beta_1)$$

$$\ln\frac{P_3}{P_1} = X(\beta_3 - \beta_1).$$

In the continuous model, let A_i represent the amount purchased by individual i and Z represent the matrix of independent variables. Then the continuous model is given by:

$$A_i = Z\gamma_i + \eta. \tag{4.3}$$

In general, $E[\eta|\delta_i = 1] \neq 0$, where δ_i represents individual i's choice. However, if $E[\eta|\delta_i = 1]$ can be estimated, then under certain assumptions the coefficients, γ_i, can be consistently estimated via:

$$A_i = Z\gamma_i + E[\eta|\delta_i = 1] + v, \tag{4.4}$$

where v has mean 0 conditional on $\delta_i = 1$. The estimate of $E[\eta|\delta_i = 1]$ is given by:

$$E[\eta|(\epsilon_1, \ldots, \epsilon_J)] = \frac{\sqrt{2}\sigma}{\lambda}\sum_{j=1}^{J} R_j\epsilon_j, \tag{4.5}$$

where $E[\epsilon_j] = 0$, the unconditional variance of ϵ_j is $\lambda^2/2$, and $\sum_{j=1}^{J} R_j = 0$. Then

Dubin and McFadden (1984) show that:

$$E[\eta|\delta_i(\epsilon)=1]=\frac{\sqrt{6}\sigma}{\pi}\left[\sum_{j=1}^{J}R_j\frac{P_j}{1-P_j}\ln P_j-R_i\frac{\ln P_i}{1-P_i}\right]. \tag{4.6}$$

In the special case of three alternatives let alternative 1 be "Do Not Purchase," alternative 2 be "Purchase Once," and alternative 3 be "Purchase Multiple Times."[3] Then imposing the constraint that $\sum_{j\in J}R_j=0$ implies that $R_1=-(R_2+R_3)$. Therefore, for people who purchase once,

$$E[\eta|\delta_2(\epsilon)=1]=R_2C_{22}+R_3C_{32}, \tag{4.7}$$

where

$$C_{22}=-\ln P_2+\frac{P_1}{1-P_1}\ln P_1 \tag{4.8}$$

and

$$C_{32}=-\frac{P_1}{1-P_1}\ln P_1-\frac{P_3}{1-P_3}\ln P_3. \tag{4.9}$$

Similarly, for people who purchase multiple times,

$$E[\eta|\delta_3(\epsilon)=1]=R_2C_{23}+R_3C_{33}, \tag{4.10}$$

where

$$C_{23}=\frac{P_2}{1-P_2}\ln P_2-\frac{P_1}{1-P_1}\ln P_1 \tag{4.11}$$

[3]Refer to the Appendix A for additional details on the data. The number of marketing orders placed in a given period is the basis for determining the consumer's choice. The detailed order data, by item, is used to determine the number of marketing orders placed.

and

$$C_{33} = -\ln P_3 + \frac{P_1}{1-P_1}\ln P_1. \tag{4.12}$$

4.3 Results of the Three-Choice Model

The first tables below gives the independent variables used in the estimation of a three-choice model.[4] The number of promotions received (i.e., catalogs, 8-prods, and solos) is included in the model. Although there may be endogeneity concerns with the causality between ordering and receiving promotions, the company develops their scoring model based on prior period activity. Hence, the number of promotions received this period are not a function of this period's orders, but rather from the customer's prior period activity.

The results of estimating a three-choice model for the period beginning December, 1993, are presented in the following tables. Note that one of the selection correction terms in the continuous equation is statistically significant and accounts for approximately 35% of the amount purchased. This implies that bias does exist, and therefore independent estimation of the propensity to purchase and the amount purchased will not yield accurate forecasts of the demand.

[4]Please refer to Appendix A for additional information on the independent variables, including the means, maximum and minimum values, and variation over time. The age brackets are: less than 25, 25 to 35, 35 to 45, 45 to 55, 55 to 65, and 65 and over. The income brackets are: less than \$10k, \$10k to \$20k, \$20k to \$30k, \$30k to \$40k, and over \$40k.

Table 4.1: Independent Variables

VARIABLE	DEFINITION
New Customer	Profile Time As Customer Less Than One Year
Old Customer	Profile Time As Customer Greater Than Three Years
Spring	Months of March, April, and May
Fall	Months of September, October, and November
Winter	Months of December, January, and February
Beginning Quarter	Month of Entry to the Model - Captures Level Effects
Trend	Relative Month in Model - Captures Relative Effects
Open Balance	ARCG Remaining Receivable Balance (in 000's)
Percent Paid	ARCG Percent Paid for all Orders on Active A/R
Declining Balance	Credit History 90 Day Declining Balance Counter
No. of Solos	Number of Back-end Solos - Promotion Detail
No. of 8 Prods	Number of Back-end 8 Prods - Promotion Detail
No. of Catalogs	Number of Back-end Catalogs - Promotion Detail
Telephone	Profile Indicator for Presence of a Telephone
Rural Route	Profile Indicator for Rural Route Address
Apartment	Profile Indicator for Residing in Apartment
Model Age	Six Age Brackets
Model Marital Status	Married is "1", Otherwise "0"
Model Children	Indicator for Presence of Children
Model Income	Five Income Brackets
Model Dwelling Type	Multiple is "0", Single is "1"
Model Housing Tenure	Rent is "0", Own is "1"
African-American	% of Population Reporting African-American - 90 Census
Latino-American	% of Population Answering Affirmative to Hispanic Origin - 90 Census
Over 65/Live Alone	% of Households with Person 65+ Living Alone - 90 Census
Single Female Household	% of Households Headed by a Single Female -90 Census

Table 4.2: Logit Estimation of Discrete Choice Model

	$\ln \frac{P_{Purchase\ Multiple}}{P_{Do\ Not\ Purchase}}$			$\ln \frac{P_{Purchase\ Once}}{P_{Do\ Not\ Purchase}}$		
VARIABLE	COEFF.†		T-STAT.	COEFF.†		T-STAT.
Constant	-3.308	***	-22.9	-4.021	***	-20.2
Telephone	0.440	***	4.6	0.254	*	1.9
Rural Route	-0.079		-1.3	-0.205	**	-2.2
Apartment	-0.008		-0.1	0.036		0.4
Open Balance This Qtr	2.249	***	26.5	3.197	***	34.0
Open Balance Last Qtr	-1.822	***	-17.8	-2.127	***	-19.2
Percent Paid	0.003	***	5.7	0.000		0.0
Declining Balance	0.279	***	10.9	0.336	***	9.8
Model Age	-0.002		-0.1	-0.001		0.1
Model Marital Status	-0.073	*	-1.8	-0.318	***	-6.0
Model Children	0.073		1.6	0.127	**	2.0
Model Income	-0.056	***	-3.6	-0.070	***	-3.1
Model Dwelling Type	0.046		0.8	-0.030		-0.4
Model Housing Tenure	0.045		0.9	-0.092		-1.4
No. of Catalogs This Qtr	0.138	***	18.9	0.229	***	24.0
No. of Catalogs Last Qtr	-0.026	***	-6.5	-0.080	***	-14.6
No. of 8 Prods This Qtr	0.062	***	3.3	0.120	***	5.0
No. of 8 Prods Last Qtr	0.027	*	1.9	0.069	***	3.6
No. of Solos This Qtr	0.235	***	14.9	0.306	***	15.8
No. of Solos Last Qtr	-0.006		-0.6	0.031	***	2.6
African-American	0.0005		0.7	0.001		1.6
Latino-American	-0.001		-1.4	-0.002	*	-1.7
Over 65/Live Alone	0.008	*	1.9	0.010	*	1.8
Single Female Household	-0.005		-1.6	-0.009	**	-2.1
New Customer	0.102	*	1.9	0.190	***	2.6
Old Customer	-0.201	***	-4.5	-0.329	***	-5.4
Log Likelihood – Initial	-42846					
Log Likelihood – Convergence	-20640					
Number of Observations	39000					

† *p=0.10, **p=0.05, ***p=0.01

Table 4.3: OLS Estimation of Dollar Amounts

	PURCHASE ONCE ‡			PURCH.2 - PURCH.1 † ‡		
VARIABLE	COEFF.§		T-STAT.	COEFF.§		T-STAT.
Constant	40.608		0.9			
R_2 Correction Term	11.354		1.1			
R_3 Correction Term	40.102	***	4.4			
Telephone	-14.323		-0.8	93.022	***	3.1
Apartment	-14.290		-1.1	17.613		0.8
Open Balance This Qtr	212.185	***	10.4	158.858	***	8.1
Open Balance Last Qtr	-105.250	***	-4.8	-115.815	***	-4.5
Percent Paid	0.208	*	1.8	-0.217		-1.0
Declining Balance	11.026	**	2.0	31.799	***	3.8
Model Age	-8.419	***	-3.3	-16.174	***	-3.9
Model Income	4.798		1.6	-9.608	*	-1.9
No. of Catalogs This Qtr	6.000	***	3.2	6.181	***	2.6
No. of Catalogs Last Qtr	-0.524		-0.7	-4.906	***	-3.9
No. of 8 Prods This Qtr	-1.551		-0.4	-9.309		-1.6
No. of 8 Prods Last Qtr	2.748		1.0	13.789	***	3.0
No. of Solos This Qtr	-1.379		-0.4	8.322	*	1.9
No. of Solos Last Qtr	-6.633	***	-3.7	-4.090		-1.5
African-American	0.226	*	1.8	-0.159		-0.8
Single Female Household	-0.388		-1.0	1.368	**	2.1
Number of Observations	8145					

† "Purch.2" is "Purchase Multiple Times," and "Purch.1" is "Purchase Once."
‡ Add the coefficients in the "Purchase Once" and "Purchase Multiple Times minus Purchase Once" columns to determine the coefficient of "Purchase Multiple Times."
§*p=0.10, **p=0.05, ***p=0.01

4.4 Comparison to Other Estimation Techniques

There are several more steps that should be considered in the implementation of discrete/continuous models of demand for direct marketing. First, most direct marketing firms promote to an individual repeatedly, over several months. The cumulative effect of the advertising should be considered, as well as the time since the last purchase. We will begin addressing these topics in the duration chapters of this dissertation.

Second, additional work should be considered for single period models. A specific promotion could be selected and three models estimated and compared - the above mentioned discrete/continuous model, a continuous/continuous model (refer to the chapter comparing the linear probability model to the logit model), and independent discrete and continuous models. Next, compare those receiving the promotional materials. Recall that pull rates of 2-4% are considered above average for direct marketing. Hence, a small fluctuation in response rates can have a significant impact on the profitability of a firm. This difference in response rate may be the result of scoring individuals differently based on the different models such that a slightly different group of customers receives a particular promotion.

Chapter 5 Comparison of Three Choice and Nested Discrete/Continuous Models

Two discrete-choice models of consumer response to direct marketing are compared in this chapter. The first is a three-choice model where the choices are purchase once, purchase multiple times, and do not purchase. The second is a nested logit approach where the first step is purchase/no purchase, and the second step is given that a purchase is made, purchase once or purchase multiple times. Following the estimation of the discrete choice models the continuous models were also executed. The continuous models employ the Dubin and McFadden selection correction terms to account for any bias in the error terms.

Although the detailed tables are presented in the following sections, they will not be discussed here.[1] Instead we will focus on comparing the results of the models.

The comparison of the log likelihoods for the two models is given in the table below. If A.I.C. (Akaike's Information Criterion) is used as a method for comparing the "fit" of the two models, the two models are indistinguishable. The difference between the log likelihood of the three-choice model and the sum of the two steps required in the nested logit approach ranges from almost zero up to eight. This is insufficient evidence upon which to base a conclusion regarding the fit of the models.

[1] Note that the results are presented for each quarter separately. The results of a Likelihood Ratio test indicate that all of the independent variable coefficients were statistically different across the quarters.

Also note that in the nested logit model, five of the nine quarters estimated have coefficients in the positive unit interval for the inclusive value (refer to Table 5.2). One quarter has an inclusive value coefficient greater than one, and the remaining three have negative coefficients for the inclusive value. Although they are not all statistically significant, this set of coefficients for the inclusive value is not consistent with a nested logit approach.

Table 5.1: Comparison of Log Likelihoods

	THREE CHOICE	NESTED		
		PURCHASE/ NO PURCHASE	PURCHASE ONCE/ PURCHASE MULTIPLE	TOTAL
	L. L.	L. L.	L. L.	L. L.
Quarter 1	-4588.7	-3402.7	-1186.6	-4589.3
Quarter 2	-4932.3	-3652.0	-1281.7	-4933.7
Quarter 3	-6011.1	-4254.0	-1758.6	-6012.6
Quarter 4	-5713.7	-4321.3	-1387.6	-5708.9
Quarter 5	-6302.1	-4685.1	-1609.7	-6294.8
Quarter 6	-7096.2	-5277.0	-1819.5	-7096.5
Quarter 7	-8298.5	-5867.0	-2429.5	-8296.5
Quarter 8	-7667.8	-5823.8	-1843.3	-7667.1
Quarter 9	-8372.7	-6216.3	-2158.5	-8374.8

The t-statistics for the selection correction terms are presented in the table below. The three-choice model includes two correction terms – one each for the "purchase once" and the "purchase multiple" options. The nested logit model has only one selection correction term because that model is only a two-choice model in the second step (given that a purchase is made, "purchase once" or "purchase multiple"). Refer to the prior chapter for additional information on the selection correction terms.[2]

With the exception of the second and third quarters (June 1992 and September 1992), the estimates for the three-choice model result in statistically significant selection correction terms. Statistically significant coefficients for the nested model are only observed in four of the nine cases. Again, as in the prior chapter, this seems to support the hypothesis that there is bias in the estimation of the dollar amount purchased, given that a purchase was made. In fact, there is even support for the hypothesis that the dollar amount spent for a single purchase is different than that spent on multiple purchases. It was also demonstrated that for the three-choice model for the quarter beginning December, 1993, the dollar amount attributable to the selection correction term is significant in terms of dollars – 35% of the amount purchased.

[2]The selection correction terms employed in this analysis are from Dubin and McFadden [11].

Table 5.2: Comparison of Selection Correction Term T-Statistics

	THREE-CHOICE		NESTED
	PURCHASE ONCE T-STATISTIC	PURCHASE MULTIPLE T-STATISTIC	PURCHASE T-STATISTIC
Quarter 1	-2.68	2.57	2.00
Quarter 2	-1.30	-0.26	1.87
Quarter 3	-0.21	-0.42	0.16
Quarter 4	-6.36	6.66	1.38
Quarter 5	-4.77	3.93	-0.81
Quarter 6	-3.11	4.23	-0.76
Quarter 7	-7.11	8.42	-1.16
Quarter 8	-4.59	5.63	-1.92
Quarter 9	-4.71	4.83	1.72

Additional analysis should be completed in this area to further develop the models. Rather than attempt to estimate a structural model with independent variables that are thought to affect the decision to purchase and the amount purchased. the company employed in this analysis would use its list of 500-600 variables (including their various transformations) to estimate a model for the propensity to purchase and the amount purchased. Perhaps they would even obtain a better fit in both models! At that point, when each logit and regression has a better "fit," the log likelihood could be compared to determine if the fits of the models are distinguishable.

One other area for further research is verifying that promotions are not endogenous to the purchase decision. The company generates its scoring models several months in advance of their implementation. Therefore, the promotions used to calibrate the model are not the same promotions as those recently received by the customers. The set of recent promotions are those used for predicting the propensity to purchase and the amount purchased.

5.1 Three-Choice Model Results

The results of the estimation of the three-choice model are presented below. The discrete choice models are presented first, followed by the continuous model estimation of the amount purchased.

Table 5.3: Probability of Purchase Once/Purchase Multiple – Quarter 1

	BUY ONCE / NO BUY			BUY MULTIPLE / NO BUY		
VARIABLE	COEFF.		T-STAT	COEFF.		T-STAT
Constant	-2.446	***	-8.34	-3.333	***	-7.99
Monthly Payment Amount	0.005		0.77	0.023	***	2.86
Monthly Payment Amount Squared	-0.000005		-0.13	-0.00001		-0.31
Age Bracket 1	0.039		0.22	-0.207		-0.88
Age Bracket 2	-0.115		-0.93	-0.471	***	-2.78
Age Bracket 3	0.012		0.11	-0.090		-0.59
Age Bracket 5	0.071		0.58	0.111		0.64
Age Bracket 6	0.218		1.54	0.421	**	2.19
Income Bracket 1	0.096		0.85	0.426	**	2.61
Income Bracket 2	0.058		0.60	0.242	*	1.66
Income Bracket 4	-0.027		-0.21	0.448	**	2.48
Income Bracket 5	-0.087		-0.66	0.116		0.57
Model Children Present	-0.012		-0.13	0.427	***	3.34
Model Dwelling Unit Type	0.038		0.35	-0.221		-1.56
Model Marital Status	0.084		1.01	-0.043		-0.38
Model Housing Tenure	-0.031		-0.30	-0.008		-0.06
Telephone Indicator	0.159		0.89	-0.321		-1.42
Rural Route Indicator	-0.281	**	-2.43	-0.096		-0.59
Years as Customer	-0.322	***	-3.81	-0.452	***	-3.74
Years as Customer Squared	0.040	***	2.75	0.050	**	2.43
Years as Customer Cubed	-0.002	**	-2.19	-0.002		-1.62
Years as Customer Fourth Power	0.00003	*	1.88	0.00003		1.09
Declining Balance 90 Days	-0.002		-0.05	-0.026		-0.40
Catalogs Sent	0.630	***	5.53	0.679	***	3.87
Catalogs Sent Squared	-0.091	***	-3.47	-0.099	**	-2.59
Catalogs Sent Cubed	0.007	***	2.92	0.007	**	2.36
Catalogs Sent Fourth Power	-0.0002	**	-2.61	-0.0002	**	-2.21
Credit Orders Last 12 Months	0.174	***	3.48	0.422	***	7.93
Credit Orders Previous	0.010	*	1.91	0.016	***	2.69
Open Balance (000's)	-0.524		-0.85	-0.170		-0.23
Open Balance Squared (000's)	0.232		0.73	-0.334		-0.91
Zero Payment Indicator	-0.162	*	-1.69	-0.289	**	-2.02
Log Likelihood – Initial	-6586.2					
Log Likelihood – At Convergence	-4588.7					
Number of Observations	5995					
Percent Correctly Predicted	67.189					

Table 5.4: Probability of Purchase Once/Purchase Multiple – Quarter 2

VARIABLE	BUYONCE / NOBUY COEFF.		T-STAT	BUYMULTIPLE / NOBUY COEFF.		T-STAT
Constant	-1.661	***	-6.43	-2.981	***	-7.60
Monthly Payment Amount	0.008		1.30	0.019	***	2.74
Monthly Payment Amount Squared	-0.00004		-1.23	-0.00008	**	-2.55
Age Bracket 1	-0.096		-0.56	0.072		0.31
Age Bracket 2	-0.257	**	-2.18	-0.043		-0.27
Age Bracket 3	-0.046		-0.44	0.201		1.38
Age Bracket 5	-0.074		-0.61	0.312	*	1.91
Age Bracket 6	-0.268	*	-1.89	0.215		1.14
Income Bracket 1	0.214	*	1.93	0.003		0.02
Income Bracket 2	0.094		1.00	-0.049		-0.39
Income Bracket 4	0.033		0.27	-0.153		-0.89
Income Bracket 5	0.143		1.11	-0.231		-1.17
Model Children Present	0.089		1.01	0.105		0.89
Model Dwelling Unit Type	-0.038		-0.37	-0.145		-1.09
Model Marital Status	-0.053		-0.64	-0.220	**	-2.05
Model Housing Tenure	0.003		0.04	0.114		0.91
Telephone Indicator	-0.289	*	-1.82	-0.423	*	-1.93
Rural Route Indicator	0.042		0.38	0.065		0.43
Years as Customer	-0.191	**	-2.38	-0.297	**	-2.64
Years as Customer Squared	0.021		1.48	0.035	*	1.84
Years as Customer Cubed	-0.0009		-1.00	-0.002		-1.44
Years as Customer Fourth Power	0.00001		0.75	0.00003		1.20
Declining Balance 90 Days	0.014		0.29	0.021		0.34
Catalogs Sent	0.336	***	4.10	0.402	***	2.78
Catalogs Sent Squared	-0.030	*	-1.94	-0.045	*	-1.72
Catalogs Sent Cubed	0.002		1.49	0.004	**	2.03
Catalogs Sent Fourth Power	-0.00003		-1.42	-0.00009	**	-2.32
Credit Orders Last 12 Months	0.066		1.41	0.327	***	7.00
Credit Orders Previous	0.002		0.32	0.010	*	1.82
Open Balance (000's)	-0.564		-0.99	-0.738		-1.18
Open Balance Squared (000's)	0.376		1.29	0.677	**	2.30
Zero Payment Indicator	-0.280	***	-3.02	-0.441	***	-3.25
Log Likelihood – Initial	-7037.7					
Log Likelihood – At Convergence	-4932.3					
Number of Observations	6406					
Percent Correctly Predicted	67.437					

Table 5.5: Probability of Purchase Once/Purchase Multiple – Quarter 3

VARIABLE	BUY ONCE / NO BUY COEFF.		BUY ONCE / NO BUY T-STAT	BUY MULTIPLE / NO BUY COEFF.		BUY MULTIPLE / NO BUY T-STAT
Constant	-1.367	***	-5.78	-2.940	***	-8.87
Monthly Payment Amount	-0.006		-0.93	0.015	**	2.03
Monthly Payment Amount Squared	0.00007	*	1.69	0.00004		0.95
Age Bracket 1	0.024		0.15	0.116		0.56
Age Bracket 2	-0.027		-0.24	0.195		1.38
Age Bracket 3	-0.037		-0.38	0.165		1.31
Age Bracket 5	0.078		0.71	0.370	**	2.61
Age Bracket 6	0.092		0.71	0.486	***	3.01
Income Bracket 1	0.086		0.87	0.194		1.50
Income Bracket 2	-0.022		-0.26	0.228	**	2.03
Income Bracket 4	-0.094		-0.84	0.130		0.86
Income Bracket 5	-0.072		-0.60	0.113		0.69
Model Children Present	-0.118		-1.43	-0.124		-1.18
Model Dwelling Unit Type	0.111		1.14	-0.011		-0.09
Model Marital Status	-0.011		-0.15	-0.225	**	-2.41
Model Housing Tenure	-0.208	**	-2.28	-0.014		-0.12
Telephone Indicator	-0.143		-0.92	-0.077		-0.37
Rural Route Indicator	0.003		0.03	0.105		0.80
Years as Customer	-0.169	**	-2.32	-0.392	***	-4.15
Years as Customer Squared	0.020		1.62	0.049	***	3.11
Years as Customer Cubed	-0.0010		-1.27	-0.002	**	-2.54
Years as Customer Fourth Power	0.00002		1.09	0.00004	**	2.22
Declining Balance 90 Days	0.022		0.51	-0.082		-1.49
Catalogs Sent	0.332	***	5.09	0.685	***	6.11
Catalogs Sent Squared	-0.035	***	-2.77	-0.121	***	-5.43
Catalogs Sent Cubed	0.002	**	2.16	0.009	***	5.58
Catalogs Sent Fourth Power	-0.00003	*	-1.70	-0.0002	***	-5.31
Credit Orders Last 12 Months	0.090	**	2.05	0.282	***	6.36
Credit Orders Previous	0.005		0.95	0.011	**	2.12
Open Balance (000's)	0.331		0.66	0.423		0.68
Open Balance Squared (000's)	-0.340		-1.36	-0.783	**	-2.28
Zero Payment Indicator	0.028		0.33	0.053		0.47
Log Likelihood – Initial	-7648.5					
Log Likelihood – At Convergence	-6011.1					
Number of Observations	6962					
Percent Correctly Predicted	60.959					

Table 5.6: Probability of Purchase Once/Purchase Multiple – Quarter 4

VARIABLE	BUYONCE / NOBUY COEFF.		BUYONCE / NOBUY T-STAT	BUYMULTIPLE / NOBUY COEFF.		BUYMULTIPLE / NOBUY T-STAT
Constant	-2.327	***	-9.14	-3.117	***	-8.41
Monthly Payment Amount	0.003		0.57	0.015	**	2.32
Monthly Payment Amount Squared	0.00004		1.14	-0.00002		-0.46
Age Bracket 1	-0.072		-0.46	-0.191		-0.87
Age Bracket 2	-0.202	*	-1.84	-0.298	*	-1.90
Age Bracket 3	-0.067		-0.70	0.003		0.02
Age Bracket 5	0.064		0.58	0.071		0.44
Age Bracket 6	0.060		0.47	0.110		0.60
Income Bracket 1	0.095		0.95	0.251	*	1.76
Income Bracket 2	0.076		0.89	0.139		1.10
Income Bracket 4	0.129		1.16	0.079		0.46
Income Bracket 5	-0.064		-0.52	-0.105		-0.54
Model Children Present	0.131		1.60	0.155		1.34
Model Dwelling Unit Type	0.073		0.75	-0.030		-0.23
Model Marital Status	-0.043		-0.58	-0.144		-1.38
Model Housing Tenure	0.016		0.18	0.042		0.35
Telephone Indicator	0.051		0.29	0.051		0.20
Rural Route Indicator	-0.051		-0.50	-0.054		-0.35
Years as Customer	-0.088		-1.26	-0.334	***	-3.31
Years as Customer Squared	0.013		1.10	0.040	**	2.36
Years as Customer Cubed	-0.0007		-1.01	-0.002	*	-1.86
Years as Customer Fourth Power	0.00001		0.97	0.00003		1.60
Declining Balance 90 Days	0.017		0.40	0.017		0.29
Catalogs Sent	0.573	***	3.62	0.478	**	2.12
Catalogs Sent Squared	-0.156	**	-2.19	-0.164	*	-1.75
Catalogs Sent Cubed	0.024	**	2.08	0.032	**	2.25
Catalogs Sent Fourth Power	-0.001	**	-2.03	-0.002	**	-2.44
Credit Orders Last 12 Months	0.159	***	3.59	0.351	***	7.20
Credit Orders Previous	0.002		0.41	0.009	**	1.98
Open Balance (000's)	0.444		1.06	1.225	**	2.34
Open Balance Squared (000's)	-0.241		-1.32	-0.416	*	-1.81
Zero Payment Indicator	0.021		0.24	-0.167		-1.19
Log Likelihood – Initial	-8359.3					
Log Likelihood – At Convergence	-5713.7					
Number of Observations	7609					
Percent Correctly Predicted	69.47					

Table 5.7: Probability of Purchase Once/Purchase Multiple – Quarter 5

VARIABLE	BUY ONCE / NO BUY COEFF.		T-STAT	BUY MULTIPLE / NO BUY COEFF.		T-STAT
Constant	-1.934	***	-7.61	-2.524	***	-7.48
Monthly Payment Amount	0.007		1.26	0.019	***	3.09
Monthly Payment Amount Squared	-0.000002		-0.06	-0.00005		-1.62
Age Bracket 1	-0.191		-1.26	-0.161		-0.80
Age Bracket 2	-0.331	***	-3.10	-0.164		-1.15
Age Bracket 3	-0.184	**	-1.97	-0.078		-0.61
Age Bracket 5	0.008		0.07	0.023		0.15
Age Bracket 6	0.174		1.37	0.269		1.59
Income Bracket 1	0.030		0.31	0.192		1.47
Income Bracket 2	-0.018		-0.22	0.029		0.25
Income Bracket 4	-0.101		-0.93	-0.175		-1.09
Income Bracket 5	-0.385	***	-3.04	-0.199		-1.11
Model Children Present	0.149	*	1.87	0.191	*	1.81
Model Dwelling Unit Type	0.104		1.11	-0.050		-0.43
Model Marital Status	-0.060		-0.83	-0.256	***	-2.72
Model Housing Tenure	-0.039		-0.44	0.050		0.45
Telephone Indicator	0.052		0.31	-0.241		-1.13
Rural Route Indicator	-0.005		-0.05	-0.253	*	-1.70
Years as Customer	-0.145	**	-2.12	-0.444	***	-4.78
Years as Customer Squared	0.012		1.01	0.051	***	3.24
Years as Customer Cubed	-0.0004		-0.58	-0.002	**	-2.39
Years as Customer Fourth Power	0.000006		0.41	0.00003	*	1.88
Declining Balance 90 Days	-0.012		-0.30	-0.072		-1.33
Catalogs Sent	0.427	***	5.23	0.416	***	3.72
Catalogs Sent Squared	-0.068	***	-3.91	-0.064	***	-2.92
Catalogs Sent Cubed	0.005	***	3.59	0.005	***	3.02
Catalogs Sent Fourth Power	-0.0001	***	-3.21	-0.0001	***	-2.88
Credit Orders Last 12 Months	0.122	***	2.96	0.252	***	5.71
Credit Orders Previous	0.004		0.89	0.018	***	4.18
Open Balance (000's)	-0.501		-1.19	0.212		0.41
Open Balance Squared (000's)	-0.010		-0.05	-0.171		-0.70
Zero Payment Indicator	-0.142	*	-1.72	0.002		0.02
Log Likelihood – Initial	-9047.1					
Log Likelihood – At Convergence	-6302.1					
Number of Observations	8235					
Percent Correctly Predicted	68.682					

Table 5.8: Probability of Purchase Once/Purchase Multiple – Quarter 6

VARIABLE	BUYONCE / NOBUY COEFF.		T-STAT	BUYMULTIPLE / NOBUY COEFF.		T-STAT
Constant	-1.729	***	-7.26	-2.751	***	-7.92
Monthly Payment Amount	0.011	**	2.07	0.022	***	4.09
Monthly Payment Amount Squared	-0.00003		-0.86	-0.00004		-1.48
Age Bracket 1	-0.100		-0.71	0.034		0.18
Age Bracket 2	-0.138		-1.38	-0.004		-0.03
Age Bracket 3	-0.097		-1.11	-0.090		-0.77
Age Bracket 5	-0.085		-0.82	0.196		1.36
Age Bracket 6	0.021		0.17	0.321	**	1.98
Income Bracket 1	0.215	**	2.34	0.259	**	2.05
Income Bracket 2	0.160	**	2.07	0.174		1.58
Income Bracket 4	0.120		1.18	0.178		1.20
Income Bracket 5	-0.066		-0.57	0.026		0.15
Model Children Present	0.064		0.86	0.105		1.02
Model Dwelling Unit Type	-0.226	**	-2.60	-0.184	*	-1.65
Model Marital Status	-0.072		-1.06	-0.298	***	-3.31
Model Housing Tenure	0.161	*	1.95	0.108		1.02
Telephone Indicator	0.018		0.11	0.109		0.45
Rural Route Indicator	0.068		0.73	-0.190		-1.31
Years as Customer	-0.252	***	-3.97	-0.364	***	-4.08
Years as Customer Squared	0.038	***	3.54	0.045	***	2.95
Years as Customer Cubed	-0.002	***	-3.11	-0.002	**	-2.29
Years as Customer Fourth Power	0.00003	***	2.78	0.00003	*	1.84
Declining Balance 90 Days	-0.029		-0.75	-0.122	**	-2.32
Catalogs Sent	0.301	***	4.09	0.285	***	2.71
Catalogs Sent Squared	-0.043	***	-2.78	-0.040	*	-1.89
Catalogs Sent Cubed	0.003	**	2.44	0.003	*	1.83
Catalogs Sent Fourth Power	-0.00006	**	-2.09	-0.00006		-1.55
Credit Orders Last 12 Months	0.148	***	3.94	0.295	***	7.24
Credit Orders Previous	-0.003		-0.71	0.010	**	2.54
Open Balance (000's)	-0.106		-0.25	-0.136		-0.29
Open Balance Squared (000's)	-0.131		-0.58	-0.121		-0.57
Zero Payment Indicator	-0.200	**	-2.55	-0.309	***	-2.76
Log Likelihood – Initial	-9891.9					
Log Likelihood – At Convergence	-7096.2					
Number of Observations	9004					
Percent Correctly Predicted	67.259					

Table 5.9: Probability of Purchase Once/Purchase Multiple – Quarter 7

VARIABLE	BUYONCE / NOBUY COEFF.		T-STAT	BUYMULTIPLE / NOBUY COEFF.		T-STAT
Constant	-1.450	***	-6.67	-2.334	***	-8.40
Monthly Payment Amount	0.001		0.20	0.022	***	3.96
Monthly Payment Amount Squared	0.00002		0.71	-0.00004		-1.25
Age Bracket 1	-0.121		-0.87	-0.079		-0.50
Age Bracket 2	-0.121		-1.26	-0.135		-1.21
Age Bracket 3	-0.078		-0.92	-0.165		-1.64
Age Bracket 5	0.119		1.18	-0.034		-0.28
Age Bracket 6	0.004		0.04	0.021		0.15
Income Bracket 1	0.059		0.67	0.075		0.72
Income Bracket 2	-0.069		-0.92	0.017		0.20
Income Bracket 4	-0.120		-1.21	-0.056		-0.47
Income Bracket 5	-0.042		-0.41	-0.191		-1.38
Model Children Present	0.195	***	2.69	0.193	**	2.28
Model Dwelling Unit Type	0.122		1.42	-0.064		-0.67
Model Marital Status	-0.090		-1.36	-0.159	**	-2.08
Model Housing Tenure	-0.088		-1.10	0.060		0.66
Telephone Indicator	-0.339	**	-2.38	-0.134		-0.70
Rural Route Indicator	-0.136		-1.39	-0.049		-0.43
Years as Customer	-0.147	**	-2.44	-0.222	***	-3.03
Years as Customer Squared	0.019	*	1.89	0.023	*	1.86
Years as Customer Cubed	-0.0009		-1.53	-0.0008		-1.13
Years as Customer Fourth Power	0.00002		1.34	0.00001		0.67
Declining Balance 90 Days	0.065	*	1.68	-0.118	***	-2.65
Catalogs Sent	0.152	**	2.64	0.168	**	2.32
Catalogs Sent Squared	-0.009		-0.90	-0.004		-0.35
Catalogs Sent Cubed	0.0004		0.60	-0.00009		-0.12
Catalogs Sent Fourth Power	-0.000005		-0.37	0.000009		0.59
Credit Orders Last 12 Months	0.035		0.85	0.294	***	7.52
Credit Orders Previous	0.0008		0.20	0.016	***	4.03
Open Balance (000's)	0.017		0.04	-0.179		-0.42
Open Balance Squared (000's)	-0.062		-0.41	-0.211		-1.07
Zero Payment Indicator	-0.029		-0.39	-0.271	***	-2.89
Log Likelihood – Initial	-10760					
Log Likelihood – At Convergence	-8298.5					
Number of Observations	9794					
Percent Correctly Predicted	63.672					

Table 5.10: Probability of Purchase Once/Purchase Multiple – Quarter 8

	BUYONCE / NOBUY			BUYMULTIPLE / NOBUY		
VARIABLE	COEFF.		T-STAT	COEFF.		T-STAT
Constant	-1.208	***	-5.59	-1.804	***	-6.12
Monthly Payment Amount	0.002		0.52	0.019	***	3.78
Monthly Payment Amount Squared	0.00001		0.70	-0.00002		-1.05
Age Bracket 1	-0.020		-0.15	-0.340	*	-1.84
Age Bracket 2	-0.159	*	-1.66	-0.301	**	-2.26
Age Bracket 3	-0.046		-0.55	0.051		0.43
Age Bracket 5	-0.008		-0.08	0.209		1.46
Age Bracket 6	0.091		0.79	0.309	*	1.90
Income Bracket 1	0.139			0.186		1.52
Income Bracket 2	0.101		1.38	-0.057		-0.53
Income Bracket 4	0.006		0.07	-0.015		-0.10
Income Bracket 5	-0.123		-1.11	0.054		0.34
Model Children Present	0.060		0.85	0.235	**	2.38
Model Dwelling Unit Type	-0.063		-0.76	-0.110		-1.05
Model Marital Status	0.028		0.44	-0.184	**	-2.08
Model Housing Tenure	0.108		1.41	-0.010		-0.10
Telephone Indicator	-0.024		-0.16	-0.424	**	-2.12
Rural Route Indicator	0.040		0.45	-0.342	**	-2.16
Years as Customer	-0.270	***	-4.59	-0.339	***	-3.95
Years as Customer Squared	0.037	***	3.78	0.038	**	2.64
Years as Customer Cubed	-0.002	***	-3.21	-0.002	**	-2.02
Years as Customer Fourth Power	0.00003	***	2.81	0.00003	*	1.65
Declining Balance 90 Days	-0.095	**	-2.59	-0.176	***	-3.49
Catalogs Sent	0.168	**	2.13	0.245	**	2.35
Catalogs Sent Squared	-0.039	*	-1.88	-0.054	**	-2.11
Catalogs Sent Cubed	0.004	**	2.19	0.005	**	2.24
Catalogs Sent Fourth Power	-0.0001	**	-2.30	-0.0001	**	-1.98
Credit Orders Last 12 Months	0.107	**	2.44	0.326	***	6.87
Credit Orders Previous	0.005		1.40	0.009	**	2.41
Open Balance (000's)	0.307		0.96	0.661	*	1.84
Open Balance Squared (000's)	-0.113		-0.96	-0.246	**	-1.99
Zero Payment Indicator	-0.684	***	-9.19	-0.974	***	-7.65
Log Likelihood – Initial	-11390					
Log Likelihood – At Convergence	-7667.8					
Number of Observations	10368					
Percent Correctly Predicted	69.956					

Table 5.11: Probability of Purchase Once/Purchase Multiple – Quarter 9

	BUYONCE / NOBUY			BUYMULTIPLE / NOBUY		
VARIABLE	COEFF.		T-STAT	COEFF.		T-STAT
Constant	-0.700	***	-3.39	-2.048	***	-7.03
Monthly Payment Amount	-0.011	**	-2.24	0.016	***	3.07
Monthly Payment Amount Squared	0.00005	**	2.10	-0.00002		-0.70
Age Bracket 1	-0.015		-0.12	-0.349	**	-2.02
Age Bracket 2	0.015		0.17	-0.083		-0.68
Age Bracket 3	-0.038		-0.47	0.085		0.77
Age Bracket 5	0.147		1.50	0.308	**	2.37
Age Bracket 6	0.115		0.99	0.209		1.39
Income Bracket 1	0.218	**	2.53	0.500	***	4.39
Income Bracket 2	0.151	**	2.13	0.304	***	3.12
Income Bracket 4	-0.032		-0.37	-0.056		-0.44
Income Bracket 5	-0.137		-1.39	-0.154		-1.07
Model Children Present	0.135	*	1.90	0.186	**	2.00
Model Dwelling Unit Type	0.049		0.66	-0.004		-0.04
Model Marital Status	-0.008		-0.13	-0.064		-0.80
Model Housing Tenure	-0.132	*	-1.81	-0.013		-0.14
Telephone Indicator	-0.278	*	-1.95	-0.255		-1.28
Rural Route Indicator	0.044		0.47	-0.170		-1.27
Years as Customer	-0.362	***	-6.32	-0.542	***	-7.09
Years as Customer Squared	0.051	***	5.36	0.072	***	5.72
Years as Customer Cubed	-0.003	***	-4.76	-0.004	***	-4.84
Years as Customer Fourth Power	0.00005	***	4.37	0.00006	***	4.29
Declining Balance 90 Days	-0.067	*	-1.86	-0.204	***	-4.37
Catalogs Sent	0.246	***	4.12	0.460	***	5.56
Catalogs Sent Squared	-0.035	***	-2.87	-0.066	***	-4.26
Catalogs Sent Cubed	0.002	**	2.49	0.004	***	3.82
Catalogs Sent Fourth Power	-0.00005	**	-2.12	-0.00008	***	-3.21
Credit Orders Last 12 Months	0.101	***	2.79	0.300	***	7.90
Credit Orders Previous	0.009	**	2.55	0.006	*	1.78
Open Balance (000's)	0.293		0.90	-0.327		-0.89
Open Balance Squared (000's)	-0.059		-0.49	-0.001		-0.01
Zero Payment Indicator	-0.774	***	-10.67	-1.151	***	-10.61
Log Likelihood – Initial	-11610					
Log Likelihood – At Convergence	-8372.7					
Number of Observations	10568					
Percent Correctly Predicted	67.118					

Table 5.12: Dollars Purchased – Quarter 1

VARIABLE	COEFF.		T-STAT
Constant	85.635	***	3.13
Selection Correction – Buy Once	-0.231	***	-2.68
Selection Correction – Buy Multiple	0.173	**	2.57
Monthly Payment Amount	0.295		0.64
Monthly Payment Amount Squared	-0.002		-1.14
Age Bracket 1	-19.264		-1.36
Age Bracket 2	-2.779		-0.27
Age Bracket 3	-3.444		-0.38
Age Bracket 5	-7.510		-0.75
Age Bracket 6	-5.367		-0.47
Income Bracket 1	-4.900		-0.52
Income Bracket 2	-2.746		-0.33
Income Bracket 4	-0.846		-0.08
Income Bracket 5	-6.787		-0.59
Model Children Present	15.537	**	2.01
Model Dwelling Unit Type	-7.612		-0.88
Model Marital Status	1.904		0.29
Model Housing Tenure	1.684		0.21
Telephone Indicator	-14.566		-1.01
Rural Route Indicator	1.177		0.12
Years as Customer	-0.257		-0.04
Years as Customer Squared	-0.170		-0.14
Years as Customer Cubed	0.016		0.22
Years as Customer Fourth Power	-0.0003		-0.24
Declining Balance 90 Days	4.541		1.19
Catalogs Sent	-6.471		-0.59
Catalogs Sent Squared	0.922		0.39
Catalogs Sent Cubed	-0.075		-0.39
Catalogs Sent Fourth Power	0.002		0.41
Credit Orders Last 12 Months	1.226		0.43
Credit Orders Previous	-0.270		-0.81
Open Balance (000's)	59.411		1.38
Open Balance Squared (000's)	26.737		1.39
Zero Payment Indicator	19.543	**	2.40
Number of Observations	2040		
R-squared	0.0711		
Corrected R-squared	0.0559		

Table 5.13: Dollars Purchased – Quarter 2

VARIABLE	COEFF.		T-STAT
Constant	-12.213		-0.47
Selection Correction – Buy Once	-0.783		-1.30
Selection Correction – Buy Multiple	-0.001		-0.26
Monthly Payment Amount	0.940	*	1.95
Monthly Payment Amount Squared	-0.008	***	-3.75
Age Bracket 1	34.318	**	2.20
Age Bracket 2	25.585	**	2.34
Age Bracket 3	17.341	*	1.76
Age Bracket 5	-3.746		-0.33
Age Bracket 6	-20.381		-1.54
Income Bracket 1	13.304		1.30
Income Bracket 2	2.654		0.30
Income Bracket 4	-9.964		-0.85
Income Bracket 5	-9.781		-0.77
Model Children Present	2.300		0.28
Model Dwelling Unit Type	-12.264		-1.30
Model Marital Status	7.467		0.98
Model Housing Tenure	13.504		1.53
Telephone Indicator	4.114		0.28
Rural Route Indicator	8.489		0.82
Years as Customer	-3.597		-0.46
Years as Customer Squared	0.735		0.55
Years as Customer Cubed	-0.040		-0.48
Years as Customer Fourth Power	0.0006		0.38
Declining Balance 90 Days	0.711		0.16
Catalogs Sent	20.554	**	2.20
Catalogs Sent Squared	-3.606	**	-2.15
Catalogs Sent Cubed	0.227	**	2.02
Catalogs Sent Fourth Power	-0.004	*	-1.77
Credit Orders Last 12 Months	14.761	***	4.70
Credit Orders Previous	-0.048		-0.13
Open Balance (000's)	-19.819		-0.47
Open Balance Squared (000's)	113.570	***	6.34
Zero Payment Indicator	12.804		1.43
Number of Observations	2163		
R-squared	0.15092		
Corrected R-squared	0.13775		

Table 5.14: Dollars Purchased – Quarter 3

VARIABLE	COEFF.		T-STAT
Constant	25.595		1.31
Selection Correction – Buy Once	-0.002		-0.21
Selection Correction – Buy Multiple	-0.000005		-0.42
Monthly Payment Amount	0.995		0.58
Monthly Payment Amount Squared	-0.00008		-0.04
Age Bracket 1	16.957		1.39
Age Bracket 2	9.725		1.16
Age Bracket 3	3.568		0.48
Age Bracket 5	-11.850		-1.43
Age Bracket 6	-22.604	**	-2.42
Income Bracket 1	4.307		0.57
Income Bracket 2	6.348		0.96
Income Bracket 4	0.814		0.09
Income Bracket 5	-0.633		-0.07
Model Children Present	-4.694		-0.74
Model Dwelling Unit Type	-8.009		-1.15
Model Marital Status	-1.536		-0.28
Model Housing Tenure	-5.214		-0.80
Telephone Indicator	23.791	**	1.96
Rural Route Indicator	-3.532		-0.45
Years as Customer	-4.968		-0.87
Years as Customer Squared	0.998		1.04
Years as Customer Cubed	-0.067		-1.15
Years as Customer Fourth Power	0.001		1.19
Declining Balance 90 Days	0.424		0.13
Catalogs Sent	2.462		0.38
Catalogs Sent Squared	-0.138		-0.11
Catalogs Sent Cubed	0.014		0.15
Catalogs Sent Fourth Power	-0.0006		-0.23
Credit Orders Last 12 Months	6.499	***	3.06
Credit Orders Previous	-0.392		-1.43
Open Balance (000's)	21.750		0.60
Open Balance Squared (000's)	-17.232		-0.92
Zero Payment Indicator	11.669	*	1.79
Number of Observations	2959		
R-squared	0.0788883		
Corrected R-squared	0.0662512		

Table 5.15: Dollars Purchased – Quarter 4

VARIABLE	COEFF.		T-STAT
Constant	59.013	**	2.38
Selection Correction – Buy Once	-0.538	***	-6.36
Selection Correction – Buy Multiple	0.555	***	6.66
Monthly Payment Amount	0.468		1.11
Monthly Payment Amount Squared	-0.004	**	-2.37
Age Bracket 1	9.211		0.64
Age Bracket 2	-3.586		-0.35
Age Bracket 3	6.071		0.69
Age Bracket 5	-0.227		-0.02
Age Bracket 6	-1.509		-0.13
Income Bracket 1	-7.775		-0.85
Income Bracket 2	-15.550	*	-1.94
Income Bracket 4	-17.309	*	-1.65
Income Bracket 5	13.300		1.11
Model Children Present	13.380	*	1.78
Model Dwelling Unit Type	-3.767		-0.45
Model Marital Status	13.503	**	2.02
Model Housing Tenure	-4.862		-0.61
Telephone Indicator	21.490		1.31
Rural Route Indicator	-2.309		-0.24
Years as Customer	4.021		0.60
Years as Customer Squared	-0.241		-0.22
Years as Customer Cubed	0.0006		0.01
Years as Customer Fourth Power	0.0001		0.08
Declining Balance 90 Days	9.482	**	2.46
Catalogs Sent	-7.824		-0.53
Catalogs Sent Squared	-2.278		-0.38
Catalogs Sent Cubed	0.508		0.57
Catalogs Sent Fourth Power	-0.023		-0.54
Credit Orders Last 12 Months	-5.230	*	-1.75
Credit Orders Previous	-0.400		-1.40
Open Balance (000's)	36.348		1.01
Open Balance Squared (000's)	40.769	***	2.67
Zero Payment Indicator	40.666	***	4.85
Number of Observations	2408		
R-squared	0.11988		
Corrected R-squared	0.10765		

Table 5.16: Dollars Purchased – Quarter 5

VARIABLE	COEFF.		T-STAT
Constant	65.470	**	2.52
Selection Correction – Buy Once	-2.287	***	-4.77
Selection Correction – Buy Multiple	0.481	***	3.93
Monthly Payment Amount	0.473		1.05
Monthly Payment Amount Squared	-0.004		-1.60
Age Bracket 1	14.329		1.00
Age Bracket 2	5.365		0.52
Age Bracket 3	3.342		0.37
Age Bracket 5	-24.193	**	-2.30
Age Bracket 6	-22.146	*	-1.88
Income Bracket 1	5.940		0.64
Income Bracket 2	4.265		0.53
Income Bracket 4	-0.295		-0.03
Income Bracket 5	18.711		1.45
Model Children Present	7.089		0.94
Model Dwelling Unit Type	-13.182		-1.55
Model Marital Status	3.315		0.49
Model Housing Tenure	22.774	***	2.85
Telephone Indicator	12.532		0.77
Rural Route Indicator	0.403		0.04
Years as Customer	-4.531		-0.65
Years as Customer Squared	0.874		0.76
Years as Customer Cubed	-0.058		-0.83
Years as Customer Fourth Power	0.001		0.86
Declining Balance 90 Days	4.900		1.26
Catalogs Sent	-7.684		-0.89
Catalogs Sent Squared	1.070		0.64
Catalogs Sent Cubed	-0.094		-0.76
Catalogs Sent Fourth Power	0.003		0.98
Credit Orders Last 12 Months	7.342	**	2.30
Credit Orders Previous	0.513		1.56
Open Balance (000's)	39.400		0.99
Open Balance Squared (000's)	28.799		1.53
Zero Payment Indicator	13.089		1.59
Number of Observations	2664		
R-squared	0.0818843		
Corrected R-squared	0.0703642		

Table 5.17: Dollars Purchased – Quarter 6

VARIABLE	COEFF.		T-STAT
Constant	61.541	**	2.49
Selection Correction – Buy Once	-1.376	***	-3.11
Selection Correction – Buy Multiple	0.523	***	4.23
Monthly Payment Amount	0.552		1.26
Monthly Payment Amount Squared	-0.005	**	-2.35
Age Bracket 1	7.562		0.57
Age Bracket 2	12.317		1.29
Age Bracket 3	9.236		1.09
Age Bracket 5	0.295		0.03
Age Bracket 6	-4.230		-0.39
Income Bracket 1	-5.708		-0.65
Income Bracket 2	1.004		0.13
Income Bracket 4	-1.605		-0.16
Income Bracket 5	-11.211		-0.96
Model Children Present	7.732		1.07
Model Dwelling Unit Type	-0.934		-0.12
Model Marital Status	-2.646		-0.41
Model Housing Tenure	-9.401		-1.25
Telephone Indicator	9.652		0.60
Rural Route Indicator	-3.300		-0.35
Years as Customer	7.197		1.15
Years as Customer Squared	-1.120		-1.07
Years as Customer Cubed	0.069		1.10
Years as Customer Fourth Power	-0.001		-1.12
Declining Balance 90 Days	1.477		0.40
Catalogs Sent	-7.119		
Catalogs Sent Squared	0.933		0.65
Catalogs Sent Cubed	-0.069		-0.66
Catalogs Sent Fourth Power	0.002		0.72
Credit Orders Last 12 Months	0.290		0.10
Credit Orders Previous	-0.520	*	-1.75
Open Balance (000's)	101.47	***	2.69
Open Balance Squared (000's)	13.664		0.76
Zero Payment Indicator	20.725	***	2.71
Number of Observations	3036		
R-squared	0.11038		
Corrected R-squared	0.10060		

Table 5.18: Dollars Purchased – Quarter 7

VARIABLE	COEFF.		T-STAT
Constant	64.719	***	2.84
Selection Correction – Buy Once	-1.509	***	-7.11
Selection Correction – Buy Multiple	1.248	***	8.42
Monthly Payment Amount	1.197	***	2.75
Monthly Payment Amount Squared	-0.002		-0.85
Age Bracket 1	12.730		0.97
Age Bracket 2	-3.027		-0.32
Age Bracket 3	-9.962		-1.19
Age Bracket 5	-3.845		-0.39
Age Bracket 6	-26.444	**	-2.36
Income Bracket 1	2.824		0.33
Income Bracket 2	-1.340		-0.18
Income Bracket 4	-5.235		-0.52
Income Bracket 5	-1.406		-0.13
Model Children Present	1.529		0.22
Model Dwelling Unit Type	-13.250	*	-1.65
Model Marital Status	17.036	***	2.70
Model Housing Tenure	-4.704		-0.63
Telephone Indicator	23.044		1.54
Rural Route Indicator	-9.156		-0.95
Years as Customer	-7.213		-1.21
Years as Customer Squared	1.154		1.15
Years as Customer Cubed	-0.063		-1.06
Years as Customer Fourth Power	0.001		0.93
Declining Balance 90 Days	3.826		1.04
Catalogs Sent	4.335		0.72
Catalogs Sent Squared	-0.835		-0.86
Catalogs Sent Cubed	0.041		0.79
Catalogs Sent Fourth Power	-0.0006		-0.52
Credit Orders Last 12 Months	0.905		0.31
Credit Orders Previous	-0.258		-0.93
Open Balance (000's)	29.176		0.82
Open Balance Squared (000's)	4.382		0.27
Zero Payment Indicator	31.442	***	4.05
Number of Observations	3838		
R-squared	0.10066		
Corrected R-squared	0.0928613		

Table 5.19: Dollars Purchased – Quarter 8

VARIABLE	COEFF.		T-STAT
Constant	34.503		1.64
Selection Correction – Buy Once	-0.338	***	-4.59
Selection Correction – Buy Multiple	0.336	***	5.63
Monthly Payment Amount	-0.638	*	-1.78
Monthly Payment Amount Squared	-0.002		-1.42
Age Bracket 1	17.810		1.38
Age Bracket 2	16.198	*	1.73
Age Bracket 3	1.847		0.22
Age Bracket 5	0.020		0.002
Age Bracket 6	-4.775		-0.43
Income Bracket 1	-11.337		-1.29
Income Bracket 2	-12.832	*	-1.72
Income Bracket 4	15.470		1.52
Income Bracket 5	-5.522		-0.49
Model Children Present	1.227		0.18
Model Dwelling Unit Type	1.056		0.14
Model Marital Status	1.508		0.24
Model Housing Tenure	-5.687		-0.78
Telephone Indicator	9.545		0.64
Rural Route Indicator	9.754		0.98
Years as Customer	9.199		1.57
Years as Customer Squared	-1.309		-1.34
Years as Customer Cubed	0.063		1.09
Years as Customer Fourth Power	-0.001		-0.90
Declining Balance 90 Days	13.954	***	3.94
Catalogs Sent	2.836		0.38
Catalogs Sent Squared	-1.327		-0.74
Catalogs Sent Cubed	0.113		0.72
Catalogs Sent Fourth Power	-0.003		-0.63
Credit Orders Last 12 Months	-0.191		-0.06
Credit Orders Previous	-0.187		-0.69
Open Balance (000's)	156.99	***	5.87
Open Balance Squared (000's)	-0.699		-0.09
Zero Payment Indicator	57.849	***	6.08
Number of Observations	3208		
R-squared	0.11921		
Corrected R-squared	0.11005		

Table 5.20: Dollars Purchased - Quarter 9

VARIABLE	COEFF.		T-STAT
Constant	15.604		0.66
Selection Correction - Buy Once	-0.399	***	-4.71
Selection Correction - Buy Multiple	0.399	***	4.83
Monthly Payment Amount	0.256		0.53
Monthly Payment Amount Squared	-0.005	**	-2.63
Age Bracket 1	24.315	*	1.70
Age Bracket 2	16.942		1.63
Age Bracket 3	13.756		1.46
Age Bracket 5	-6.605		-0.60
Age Bracket 6	-31.144		-0.43
Income Bracket 1	2.950		0.30
Income Bracket 2	5.502		0.67
Income Bracket 4	-5.696		-0.54
Income Bracket 5	-3.777		-0.31
Model Children Present	-1.944		-0.24
Model Dwelling Unit Type	-5.003		-0.61
Model Marital Status	12.204	*	1.74
Model Housing Tenure	-1.549		-0.19
Telephone Indicator	20.132		1.25
Rural Route Indicator	-6.086		-0.55
Years as Customer	-0.644		-0.10
Years as Customer Squared	0.047		0.04
Years as Customer Cubed	-0.0007		-0.01
Years as Customer Fourth Power	-0.00002		-0.02
Declining Balance 90 Days	-2.875		-0.72
Catalogs Sent	15.759	**	2.20
Catalogs Sent Squared	-2.388	*	-1.82
Catalogs Sent Cubed	0.126		1.43
Catalogs Sent Fourth Power	-0.002		-1.08
Credit Orders Last 12 Months	1.876		0.57
Credit Orders Previous	-0.275		-0.92
Open Balance (000's)	115.14	***	3.22
Open Balance Squared (000's)	4.055		0.33
Zero Payment Indicator	30.390	***	3.20
Number of Observations	3562		
R-squared	0.0668705		
Corrected R-squared	0.0581423		

5.2 Two-Level Binary Choice Results

The results of the two-level binary choice model are presented below. For each of the nine quarters analyzed, the second step, or "purchase once" versus "purchase multiple times" is given first. Next, the binary decision of "purchase" versus "no purchase" is listed. Finally, for each of the nine quarters, the estimation of the dollar amount purchased is presented.

Table 5.21: Buy Once/Buy Multiple Given Purchase – Quarter 1

VARIABLE	COEFF.		T-STAT
Constant	-0.902	*	-1.84
Monthly Payment Amount	0.016	*	1.86
Monthly Payment Amount Squared	-0.000003		-0.08
Age Bracket 1	-0.237		-0.91
Age Bracket 2	-0.378	**	-2.01
Age Bracket 3	-0.090		-0.54
Age Bracket 5	0.016		0.09
Age Bracket 6	0.193		0.91
Income Bracket 1	0.352	**	1.97
Income Bracket 2	0.162		1.02
Income Bracket 4	0.455	**	2.29
Income Bracket 5	0.225		1.02
Model Children Present	0.449	***	3.15
Model Dwelling Unit Type	-0.246		-1.58
Model Marital Status	-0.098		-0.80
Model Housing Tenure	-0.011		-0.08
Telephone Indicator	-0.501	*	-1.94
Rural Route Indicator	0.122		0.67
Years as Customer	-0.127		-0.97
Years as Customer Squared	0.012		0.55
Years as Customer Cubed	-0.0003		-0.19
Years as Customer Fourth Power	-0.000002		-0.07
Declining Balance 90 Days	-0.006		-0.08
Catalogs Sent	0.002		0.01
Catalogs Sent Squared	0.002		0.03
Catalogs Sent Cubed	0.0002		0.06
Catalogs Sent Fourth Power	-0.00001		-0.11
Credit Orders Last 12 Months	0.239	***	4.49
Credit Orders Previous	0.004		0.64
Open Balance (000's)	0.458		0.59
Open Balance Squared (000's)	-0.556		-1.54
Zero Payment Indicator	-0.098		-0.63
Log Likelihood – Initial	-1414		
Log Likelihood – At Convergence	-1186.6		
Number of Observations	2040		
Percent Correctly Predicted	70.196		

Table 5.22: Buy Once/Buy Multiple Given Purchase – Quarter 2

VARIABLE	COEFF.		T-STAT
Constant	-1.431	***	-3.27
Monthly Payment Amount	0.011		1.43
Monthly Payment Amount Squared	-0.00005		-1.23
Age Bracket 1	0.142		0.56
Age Bracket 2	0.165		0.92
Age Bracket 3	0.207		1.27
Age Bracket 5	0.326	*	1.77
Age Bracket 6	0.510	**	2.40
Income Bracket 1	-0.212		-1.30
Income Bracket 2	-0.107		-0.75
Income Bracket 4	-0.213		-1.11
Income Bracket 5	-0.373	*	-1.72
Model Children Present	0.053		0.40
Model Dwelling Unit Type	-0.105		-0.70
Model Marital Status	-0.125		-1.04
Model Housing Tenure	0.050		0.35
Telephone Indicator	-0.145		-0.61
Rural Route Indicator	0.015		0.09
Years as Customer	-0.077		-0.61
Years as Customer Squared	0.011		0.51
Years as Customer Cubed	-0.0007		-0.50
Years as Customer Fourth Power	0.00001		0.48
Declining Balance 90 Days	0.018		0.26
Catalogs Sent	0.083		0.54
Catalogs Sent Squared	-0.013		-0.52
Catalogs Sent Cubed	0.002		0.99
Catalogs Sent Fourth Power	-0.00004		-1.30
Credit Orders Last 12 Months	0.253	***	4.73
Credit Orders Previous	0.006		0.99
Open Balance (000's)	-0.117		-0.17
Open Balance Squared (000's)	0.286		0.98
Zero Payment Indicator	-0.098		-0.66
Log Likelihood – Initial	-1499.3		
Log Likelihood – At Convergence	-1281.7		
Number of Observations	2163		
Percent Correctly Predicted	68.978		

Table 5.23: Buy Once/Buy Multiple Given Purchase – Quarter 3

VARIABLE	COEFF.		T-STAT
Constant	-1.533	***	-4.18
Monthly Payment Amount	0.022	***	3.10
Monthly Payment Amount Squared	-0.00003		-0.93
Age Bracket 1	0.094		0.42
Age Bracket 2	0.244		1.57
Age Bracket 3	0.168		1.21
Age Bracket 5	0.293	*	1.90
Age Bracket 6	0.440	**	2.54
Income Bracket 1	0.114		0.82
Income Bracket 2	0.251	**	2.05
Income Bracket 4	0.187		1.12
Income Bracket 5	0.218		1.20
Model Children Present	0.027		0.23
Model Dwelling Unit Type	-0.162		-1.27
Model Marital Status	-0.180	*	-1.78
Model Housing Tenure	0.168		1.41
Telephone Indicator	0.064		0.28
Rural Route Indicator	0.060		0.42
Years as Customer	-0.234	**	-2.23
Years as Customer Squared	0.032	*	1.83
Years as Customer Cubed	-0.002		-1.58
Years as Customer Fourth Power	0.00003		1.42
Declining Balance 90 Days	-0.104	*	-1.74
Catalogs Sent	0.272	**	2.19
Catalogs Sent Squared	-0.067	***	-2.70
Catalogs Sent Cubed	0.006	***	3.13
Catalogs Sent Fourth Power	-0.0001	***	-3.11
Credit Orders Last 12 Months	0.201	***	4.41
Credit Orders Previous	0.006		1.12
Open Balance (000's)	0.044		0.07
Open Balance Squared (000's)	-0.440		-1.26
Zero Payment Indicator	0.096		0.78
Log Likelihood – Initial	-2051		
Log Likelihood – At Convergence	-1758.6		
Number of Observations	2959		
Percent Correctly Predicted	69.111		

Table 5.24: Buy Once/Buy Multiple Given Purchase – Quarter 4

VARIABLE	COEFF.		T-STAT
Constant	-0.813	*	-1.90
Monthly Payment Amount	0.010		1.56
Monthly Payment Amount Squared	-0.00005	*	-1.78
Age Bracket 1	0.006		0.02
Age Bracket 2	-0.024		-0.13
Age Bracket 3	0.130		0.85
Age Bracket 5	-0.010		-0.06
Age Bracket 6	-0.015		-0.08
Income Bracket 1	0.228		1.44
Income Bracket 2	0.094		0.67
Income Bracket 4	-0.018		-0.10
Income Bracket 5	0.104		0.48
Model Children Present	-0.013		-0.10
Model Dwelling Unit Type	-0.124		-0.87
Model Marital Status	-0.076		-0.66
Model Housing Tenure	0.053		0.39
Telephone Indicator	0.008		0.03
Rural Route Indicator	0.002		0.01
Years as Customer	-0.263	**	-2.29
Years as Customer Squared	0.031		1.60
Years as Customer Cubed	-0.001		-1.25
Years as Customer Fourth Power	0.00002		1.07
Declining Balance 90 Days	0.016		0.24
Catalogs Sent	-0.204		-0.79
Catalogs Sent Squared	0.020		0.20
Catalogs Sent Cubed	0.006		0.42
Catalogs Sent Fourth Power	-0.0005		-0.68
Credit Orders Last 12 Months	0.179	***	3.58
Credit Orders Previous	0.010	**	2.06
Open Balance (000's)	0.965	*	1.66
Open Balance Squared (000's)	-0.235		-0.97
Zero Payment Indicator	-0.194		-1.29
Log Likelihood – Initial	-1669.1		
Log Likelihood – At Convergence	-1387.6		
Number of Observations	2408		
Percent Correctly Predicted	70.64		

Table 5.25: Buy Once/Buy Multiple Given Purchase - Quarter 5

VARIABLE	COEFF.		T-STAT
Constant	-0.561		-1.43
Monthly Payment Amount	-0.011		1.54
Monthly Payment Amount Squared	-0.00005		-1.40
Age Bracket 1	0.028		0.12
Age Bracket 2	0.201		1.24
Age Bracket 3	0.124		0.87
Age Bracket 5	-0.0009		-0.01
Age Bracket 6	0.039		0.21
Income Bracket 1	0.184		1.25
Income Bracket 2	0.050		0.39
Income Bracket 4	-0.081		-0.46
Income Bracket 5	0.097		0.47
Model Children Present	0.041		0.35
Model Dwelling Unit Type	-0.139		-1.06
Model Marital Status	-0.178	*	-1.69
Model Housing Tenure	0.070		0.57
Telephone Indicator	-0.353		-1.43
Rural Route Indicator	-0.259		-1.59
Years as Customer	-0.316	***	-2.99
Years as Customer Squared	0.042	**	2.31
Years as Customer Cubed	-0.002	*	-1.80
Years as Customer Fourth Power	0.00003		1.43
Declining Balance 90 Days	-0.060		-0.98
Catalogs Sent	-0.091		-0.67
Catalogs Sent Squared	0.022		0.83
Catalogs Sent Cubed	-0.001		-0.69
Catalogs Sent Fourth Power	0.00003		0.62
Credit Orders Last 12 Months	0.137	***	2.91
Credit Orders Previous	0.016	***	3.19
Open Balance (000's)	0.944		1.57
Open Balance Squared (000's)	-0.219		-0.77
Zero Payment Indicator	0.193		1.45
Log Likelihood - Initial	-1846.5		
Log Likelihood - At Convergence	-1609.7		
Number of Observations	2664		
Percent Correctly Predicted	68.093		

Table 5.26: Buy Once/Buy Multiple Given Purchase – Quarter 6

VARIABLE	COEFF.		T-STAT
Constant	-1.124	***	-2.89
Monthly Payment Amount	0.010		1.38
Monthly Payment Amount Squared	-0.000006		-0.15
Age Bracket 1	0.167		0.79
Age Bracket 2	0.113		0.74
Age Bracket 3	0.009		0.06
Age Bracket 5	0.281	*	1.77
Age Bracket 6	0.255		1.46
Income Bracket 1	0.069		0.49
Income Bracket 2	0.026		0.22
Income Bracket 4	0.044		0.27
Income Bracket 5	0.066		0.35
Model Children Present	0.049		0.42
Model Dwelling Unit Type	0.039		0.32
Model Marital Status	-0.209	**	-2.09
Model Housing Tenure	-0.064		-0.54
Telephone Indicator	0.116		0.44
Rural Route Indicator	-0.275	*	-1.75
Years as Customer	-0.091		-0.93
Years as Customer Squared	0.003		0.17
Years as Customer Cubed	0.0002		0.15
Years as Customer Fourth Power	-0.000007		-0.33
Declining Balance 90 Days	-0.063		-1.08
Catalogs Sent	-0.016		-0.13
Catalogs Sent Squared	0.003		0.14
Catalogs Sent Cubed	-0.0001		-0.06
Catalogs Sent Fourth Power	0.000005		0.12
Credit Orders Last 12 Months	0.148	***	3.54
Credit Orders Previous	0.016	***	3.19
Open Balance (000's)	0.004		0.07
Open Balance Squared (000's)	-0.045		-0.15
Zero Payment Indicator	-0.068		-0.54
Log Likelihood – Initial	-2104.4		
Log Likelihood – At Convergence	-1819.5		
Number of Observations	3036		
Percent Correctly Predicted	69.236		

Table 5.27: Buy Once/Buy Multiple Given Purchase - Quarter 7

VARIABLE	COEFF.		T-STAT
Constant	-0.922	***	-2.95
Monthly Payment Amount	0.021	***	3.50
Monthly Payment Amount Squared	-0.00006	*	-1.94
Age Bracket 1	0.120		0.67
Age Bracket 2	0.045		0.35
Age Bracket 3	-0.065		-0.57
Age Bracket 5	-0.162		-1.19
Age Bracket 6	-0.010		-0.06
Income Bracket 1	0.016		0.14
Income Bracket 2	0.090		0.90
Income Bracket 4	0.076		0.55
Income Bracket 5	-0.189		-1.22
Model Children Present	-0.027		-0.28
Model Dwelling Unit Type	-0.183	*	-1.68
Model Marital Status	-0.060		-0.70
Model Housing Tenure	0.125		1.21
Telephone Indicator	0.206		0.98
Rural Route Indicator	0.079		0.60
Years as Customer	-0.061		-0.75
Years as Customer Squared	0.0007		0.05
Years as Customer Cubed	0.0003		0.40
Years as Customer Fourth Power	-0.00001		-0.72
Declining Balance 90 Days	-0.177	***	-3.54
Catalogs Sent	-0.035		-0.41
Catalogs Sent Squared	0.016		1.13
Catalogs Sent Cubed	-0.001		-1.44
Catalogs Sent Fourth Power	0.00003	*	1.75
Credit Orders Last 12 Months	0.241	***	5.49
Credit Orders Previous	0.017	***	3.84
Open Balance (000's)	-0.151		-0.31
Open Balance Squared (000's)	-0.225		-1.02
Zero Payment Indicator	-0.201	*	-1.90
Log Likelihood - Initial	-2660.3		
Log Likelihood - At Convergence	-2429.5		
Number of Observations	3838		
Percent Correctly Predicted	65.008		

Table 5.28: Buy Once/Buy Multiple Given Purchase – Quarter 8

VARIABLE	COEFF.		T-STAT
Constant	-0.765	**	-2.30
Monthly Payment Amount	0.019	***	3.48
Monthly Payment Amount Squared	-0.00004	**	-2.19
Age Bracket 1	-0.282		-1.36
Age Bracket 2	-0.108		-0.72
Age Bracket 3	0.125		0.94
Age Bracket 5	0.191		1.19
Age Bracket 6	0.111		0.62
Income Bracket 1	0.101		0.73
Income Bracket 2	-0.134		-1.11
Income Bracket 4	-0.013		-0.08
Income Bracket 5	0.158		0.87
Model Children Present	0.173		1.56
Model Dwelling Unit Type	-0.066		-0.55
Model Marital Status	-0.206	**	-2.08
Model Housing Tenure	-0.111		-0.97
Telephone Indicator	-0.329		-1.42
Rural Route Indicator	-0.440	**	-2.55
Years as Customer	-0.048		-0.51
Years as Customer Squared	0.00007		0.004
Years as Customer Cubed	0.0001		0.11
Years as Customer Fourth Power	-0.000003		-0.15
Declining Balance 90 Days	-0.071		-1.25
Catalogs Sent	0.020		0.16
Catalogs Sent Squared	-0.004		-0.11
Catalogs Sent Cubed	0.000003		0.001
Catalogs Sent Fourth Power	0.00003		0.31
Credit Orders Last 12 Months	0.221	***	4.18
Credit Orders Previous	0.005		1.21
Open Balance (000's)	0.255		0.64
Open Balance Squared (000's)	-0.126		-1.05
Zero Payment Indicator	-0.175		-1.26
Log Likelihood – Initial	-2223.6		
Log Likelihood – At Convergence	-1843.3		
Number of Observations	3208		
Percent Correctly Predicted	71.197		

Table 5.29: Buy Once/Buy Multiple Given Purchase – Quarter 9

VARIABLE	COEFF.		T-STAT
Constant	-1.325	***	-4.13
Monthly Payment Amount	0.028	***	4.41
Monthly Payment Amount Squared	-0.00006	**	-2.06
Age Bracket 1	-0.239		-1.25
Age Bracket 2	-0.031		-0.23
Age Bracket 3	0.186		1.48
Age Bracket 5	0.186		1.28
Age Bracket 6	0.086		0.51
Income Bracket 1	0.295	**	2.30
Income Bracket 2	0.193	*	1.77
Income Bracket 4	-0.039		-0.27
Income Bracket 5	-0.029		-0.17
Model Children Present	0.018		0.17
Model Dwelling Unit Type	-0.050		-0.47
Model Marital Status	-0.025		-0.27
Model Housing Tenure	0.083		0.79
Telephone Indicator	0.031		0.14
Rural Route Indicator	-0.268	*	-1.79
Years as Customer	-0.189	**	-2.24
Years as Customer Squared	0.023	*	1.65
Years as Customer Cubed	-0.001		-1.19
Years as Customer Fourth Power	0.00001		0.88
Declining Balance 90 Days	-0.132	**	-2.53
Catalogs Sent	0.184	*	1.91
Catalogs Sent Squared	-0.028		-1.59
Catalogs Sent Cubed	0.002		1.51
Catalogs Sent Fourth Power	-0.00003		-1.26
Credit Orders Last 12 Months	0.218	***	5.00
Credit Orders Previous	-0.004		-1.01
Open Balance (000's)	-0.909	**	-1.98
Open Balance Squared (000's)	0.079		0.50
Zero Payment Indicator	-0.375	***	-3.18
Log Likelihood – Initial	-2469		
Log Likelihood – At Convergence	-2158.5		
Number of Observations	3562		
Percent Correctly Predicted	67.687		

Table 5.30: Buy/No Buy - Quarter 1

VARIABLE	COEFF.		T-STAT
Constant	-2.335	***	-6.73
Monthly Payment Amount	0.008		1.10
Monthly Payment Amount Squared	-0.000003		-0.09
Age Bracket 1	0.016		0.10
Age Bracket 2	-0.143		-1.07
Age Bracket 3	-0.001		-0.01
Age Bracket 5	0.079		0.71
Age Bracket 6	0.238	*	1.81
Income Bracket 1	0.118		0.98
Income Bracket 2	0.075		0.82
Income Bracket 4	0.017		0.12
Income Bracket 5	-0.075		-0.60
Model Children Present	0.025		0.21
Model Dwelling Unit Type	0.009		0.08
Model Marital Status	0.066		0.85
Model Housing Tenure	-0.019		-0.21
Telephone Indicator	0.117		0.63
Rural Route Indicator	-0.252	**	-2.40
Years as Customer	-0.332	***	-4.19
Years as Customer Squared	0.040	***	3.03
Years as Customer Cubed	-0.002	**	-2.37
Years as Customer Fourth Power	0.00003	**	1.98
Declining Balance 90 Days	-0.011		-0.24
Catalogs Sent	0.645	***	6.37
Catalogs Sent Squared	-0.094	***	-4.04
Catalogs Sent Cubed	0.007	***	3.40
Catalogs Sent Fourth Power	-0.0002	***	-3.03
Credit Orders Last 12 Months	0.206	***	2.71
Credit Orders Previous	0.011	**	2.36
Open Balance (000's)	-0.517		-0.93
Open Balance Squared (000's)	0.149		0.45
Zero Payment Indicator	-0.169	*	-1.94
Inclusive Value	0.694		1.06
Log Likelihood - Initial	-4155.4		
Log Likelihood - At Convergence	-3402.7		
Number of Observations	5995		
Percent Correctly Predicted	70.359		

Table 5.31: Buy/No Buy - Quarter 2

VARIABLE	COEFF.		T-STAT
Constant	-1.752	*	-6.64
Monthly Payment Amount	0.005		0.86
Monthly Payment Amount Squared	-0.00003		-0.96
Age Bracket 1	-0.115		-0.73
Age Bracket 2	-0.275	**	-2.50
Age Bracket 3	-0.073		-0.73
Age Bracket 5	-0.117		-0.94
Age Bracket 6	-0.380	**	-2.35
Income Bracket 1	0.255	**	2.39
Income Bracket 2	0.103		1.20
Income Bracket 4	0.081		0.69
Income Bracket 5	0.203		1.55
Model Children Present	0.071		0.90
Model Dwelling Unit Type	-0.017		-0.18
Model Marital Status	-0.042		-0.54
Model Housing Tenure	0.010		0.12
Telephone Indicator	-0.258	*	-1.76
Rural Route Indicator	0.042		0.43
Years as Customer	-0.188	***	-2.57
Years as Customer Squared	0.020		1.59
Years as Customer Cubed	-0.0008		-1.05
Years as Customer Fourth Power	0.00001		0.76
Declining Balance 90 Days	0.009		0.23
Catalogs Sent	0.296	***	3.56
Catalogs Sent Squared	-0.022		-1.33
Catalogs Sent Cubed	0.0009		0.76
Catalogs Sent Fourth Power	-0.00002		-0.73
Credit Orders Last 12 Months	0.003		0.03
Credit Orders Previous	0.001		0.21
Open Balance (000's)	-0.516		-1.02
Open Balance Squared (000's)	0.291		1.07
Zero Payment Indicator	-0.287	***	-3.43
Inclusive Value	1.621	***	2.62
Log Likelihood - Initial	-4440.3		
Log Likelihood - At Convergence	-3652		
Number of Observations	6406		
Percent Correctly Predicted	70.45		

Table 5.32: Buy/No Buy - Quarter 3

VARIABLE	COEFF.		T-STAT
Constant	-1.365	***	-6.14
Monthly Payment Amount	-0.006		-0.81
Monthly Payment Amount Squared	0.00007	*	1.76
Age Bracket 1	0.023		0.16
Age Bracket 2	-0.032		-0.31
Age Bracket 3	-0.024		-0.27
Age Bracket 5	0.081		0.76
Age Bracket 6	0.081		0.61
Income Bracket 1	0.086		0.95
Income Bracket 2	-0.020		-0.24
Income Bracket 4	-0.081		-0.77
Income Bracket 5	-0.079		-0.71
Model Children Present	-0.127	*	-1.73
Model Dwelling Unit Type	0.122		1.34
Model Marital Status	-0.024		-0.34
Model Housing Tenure	-0.196	**	-2.28
Telephone Indicator	-0.143		-1.01
Rural Route Indicator	0.017		0.18
Years as Customer	-0.168	**	-2.32
Years as Customer Squared	0.019		1.63
Years as Customer Cubed	-0.0009		-1.28
Years as Customer Fourth Power	0.00002		1.10
Declining Balance 90 Days	0.021		0.48
Catalogs Sent	0.345	***	4.68
Catalogs Sent Squared	-0.038	**	-2.40
Catalogs Sent Cubed	0.002	*	1.76
Catalogs Sent Fourth Power	-0.00004		-1.43
Credit Orders Last 12 Months	0.089		1.57
Credit Orders Previous	0.005		1.06
Open Balance (000's)	0.347		0.76
Open Balance Squared (000's)	-0.343		-1.41
Zero Payment Indicator	0.011		0.14
Inclusive Value	0.964	**	2.14
Log Likelihood - Initial	-4825.7		
Log Likelihood - At Convergence	-4254		
Number of Observations	6962		
Percent Correctly Predicted	66.231		

Table 5.33: Buy/No Buy – Quarter 4

VARIABLE	COEFF.		T-STAT
Constant	-1.622	***	-5.47
Monthly Payment Amount	0.010	*	1.87
Monthly Payment Amount Squared	0.00001		0.36
Age Bracket 1	-0.106		-0.76
Age Bracket 2	-0.238	**	-2.41
Age Bracket 3	-0.010		-0.11
Age Bracket 5	0.068		0.68
Age Bracket 6	0.076		0.66
Income Bracket 1	0.204	**	2.11
Income Bracket 2	0.116		1.49
Income Bracket 4	0.111		1.09
Income Bracket 5	-0.048		-0.42
Model Children Present	0.134	*	1.82
Model Dwelling Unit Type	0.003		0.03
Model Marital Status	-0.099		-1.45
Model Housing Tenure	0.045		0.55
Telephone Indicator	0.046		0.29
Rural Route Indicator	-0.046		-0.49
Years as Customer	-0.222	***	-3.02
Years as Customer Squared	0.028	**	2.41
Years as Customer Cubed	-0.001	**	-2.02
Years as Customer Fourth Power	0.00002	*	1.82
Declining Balance 90 Days	0.011		0.29
Catalogs Sent	0.563	***	4.11
Catalogs Sent Squared	-0.188	***	-3.08
Catalogs Sent Cubed	0.033	***	3.32
Catalogs Sent Fourth Power	-0.002	***	-3.27
Credit Orders Last 12 Months	0.299	***	5.53
Credit Orders Previous	0.084	**	2.02
Open Balance (000's)	1.060	**	2.51
Open Balance Squared (000's)	-0.392	**	-2.21
Zero Payment Indicator	-0.001		-0.02
Inclusive Value	-1.002	*	-1.82
Log Likelihood – Initial	-5274.2		
Log Likelihood – At Convergence	-4321.3		
Number of Observations	7609		
Percent Correctly Predicted	71.271		

Table 5.34: Buy/No Buy - Quarter 5

VARIABLE	COEFF.		T-STAT
Constant	-0.957	***	-3.03
Monthly Payment Amount	0.017	***	3.32
Monthly Payment Amount Squared	-0.00004		-1.56
Age Bracket 1	-0.191		-1.42
Age Bracket 2	-0.208	**	-2.09
Age Bracket 3	-0.115		-1.35
Age Bracket 5	0.017		0.17
Age Bracket 6	0.218	*	1.91
Income Bracket 1	0.157	*	1.70
Income Bracket 2	0.013		0.18
Income Bracket 4	-0.146		-1.48
Income Bracket 5	-0.293	***	-2.60
Model Children Present	0.171	**	2.42
Model Dwelling Unit Type	-0.0008		-0.01
Model Marital Status	-0.194	***	-2.77
Model Housing Tenure	0.016		0.21
Telephone Indicator	-0.195		-1.23
Rural Route Indicator	-0.155		-1.59
Years as Customer	-0.356	***	-4.53
Years as Customer Squared	0.039	***	3.19
Years as Customer Cubed	-0.002	**	-2.38
Years as Customer Fourth Power	0.00002	*	1.87
Declining Balance 90 Days	-0.065	*	-1.70
Catalogs Sent	0.424	***	6.04
Catalogs Sent Squared	-0.065	***	-4.42
Catalogs Sent Cubed	0.005	***	4.18
Catalogs Sent Fourth Power	-0.0001	***	-3.65
Credit Orders Last 12 Months	0.248	***	5.33
Credit Orders Previous	0.019	***	3.68
Open Balance (000's)	0.171		0.43
Open Balance Squared (000's)	-0.146		-0.85
Zero Payment Indicator	0.017		0.20
Inclusive Value	-1.204	**	-2.38
Log Likelihood - Initial	-5708.1		
Log Likelihood - At Convergence	-4685.1		
Number of Observations	8235		
Percent Correctly Predicted	71.075		

Table 5.35: Buy/No Buy - Quarter 6

VARIABLE	COEFF.		T-STAT
Constant	-1.525	***	-5.48
Monthly Payment Amount	0.013	***	2.93
Monthly Payment Amount Squared	-0.00002		-0.97
Age Bracket 1	-0.078		-0.60
Age Bracket 2	-0.111		-1.20
Age Bracket 3	-0.099		-1.26
Age Bracket 5	-0.032		-0.29
Age Bracket 6	0.084		0.70
Income Bracket 1	0.220	***	2.65
Income Bracket 2	0.161	**	2.32
Income Bracket 4	0.133		1.45
Income Bracket 5	-0.044		-0.43
Model Children Present	0.069		1.02
Model Dwelling Unit Type	-0.217	***	-2.79
Model Marital Status	-0.118		-1.62
Model Housing Tenure	0.151	**	2.05
Telephone Indicator	0.033		0.23
Rural Route Indicator	0.030		0.31
Years as Customer	-0.274	***	-4.61
Years as Customer Squared	0.039	***	4.08
Years as Customer Cubed	-0.002	***	-3.48
Years as Customer Fourth Power	0.00003	***	3.02
Declining Balance 90 Days	-0.053		-1.40
Catalogs Sent	0.301	***	4.68
Catalogs Sent Squared	-0.043	***	-3.16
Catalogs Sent Cubed	0.003	***	2.77
Catalogs Sent Fourth Power	-0.00006	**	-2.30
Credit Orders Last 12 Months	0.184	***	3.64
Credit Orders Previous	0.0002		0.04
Open Balance (000's)	-0.131		-0.37
Open Balance Squared (000's)	-0.122		-0.71
Zero Payment Indicator	-0.221	***	-3.19
Inclusive Value	0.374		0.58
Log Likelihood - Initial	-6241.1		
Log Likelihood - At Convergence	-5277		
Number of Observations	9004		
Percent Correctly Predicted	69.991		

Table 5.36: Buy/No Buy – Quarter 7

VARIABLE	COEFF.		T-STAT
Constant	-1.033	***	-4.32
Monthly Payment Amount	0.014	**	2.13
Monthly Payment Amount Squared	-0.00001		-0.41
Age Bracket 1	-0.094		-0.78
Age Bracket 2	-0.122		-1.46
Age Bracket 3	-0.120		-1.61
Age Bracket 5	0.054		0.59
Age Bracket 6	0.019		0.19
Income Bracket 1	0.068		0.88
Income Bracket 2	-0.024		-0.36
Income Bracket 4	-0.091		-1.06
Income Bracket 5	-0.099		-1.04
Model Children Present	0.189	***	3.02
Model Dwelling Unit Type	0.026		0.33
Model Marital Status	-0.123	**	-2.13
Model Housing Tenure	-0.014		-0.19
Telephone Indicator	-0.258	**	-1.97
Rural Route Indicator	-0.094		-1.12
Years as Customer	-0.181	***	-3.40
Years as Customer Squared	0.020	**	2.29
Years as Customer Cubed	-0.0008		-1.57
Years as Customer Fourth Power	0.00001		1.15
Declining Balance 90 Days	-0.034		-0.70
Catalogs Sent	0.153	***	3.08
Catalogs Sent Squared	-0.005		-0.51
Catalogs Sent Cubed	-0.00005		-0.08
Catalogs Sent Fourth Power	0.000008		0.57
Credit Orders Last 12 Months	0.198	***	3.06
Credit Orders Previous	0.010	**	2.02
Open Balance (000's)	-0.231		-0.68
Open Balance Squared (000's)	-0.099		-0.69
Zero Payment Indicator	-0.111		-1.61
Inclusive Value	-0.249		-0.56
Log Likelihood – Initial	-6788.7		
Log Likelihood – At Convergence	-5867		
Number of Observations	9794		
Percent Correctly Predicted	67.899		

Table 5.37: Buy/No Buy - Quarter 8

VARIABLE	COEFF.		T-STAT
Constant	-0.844	***	-3.56
Monthly Payment Amount	0.007		1.54
Monthly Payment Amount Squared	0.000007		0.39
Age Bracket 1	-0.105		-0.86
Age Bracket 2	-0.198	**	-2.30
Age Bracket 3	-0.024		-0.32
Age Bracket 5	0.048		0.52
Age Bracket 6	0.159		1.50
Income Bracket 1	0.151	*	1.90
Income Bracket 2	0.063		0.93
Income Bracket 4	0.00008		0.00
Income Bracket 5	-0.078		-0.78
Model Children Present	0.107		1.60
Model Dwelling Unit Type	-0.072		-1.00
Model Marital Status	-0.027		-0.44
Model Housing Tenure	0.072		1.05
Telephone Indicator	-0.130		-0.95
Rural Route Indicator	-0.028		-0.30
Years as Customer	-0.286	***	-5.38
Years as Customer Squared	0.037	***	4.18
Years as Customer Cubed	-0.002	***	-3.46
Years as Customer Fourth Power	0.00003	***	2.99
Declining Balance 90 Days	-0.120	***	-3.51
Catalogs Sent	0.176	***	2.65
Catalogs Sent Squared	-0.037	***	-2.15
Catalogs Sent Cubed	0.004	**	2.29
Catalogs Sent Fourth Power	-0.0001	**	-2.06
Credit Orders Last 12 Months	0.184	***	3.55
Credit Orders Previous	0.006	*	1.92
Open Balance (000's)	0.411		1.46
Open Balance Squared (000's)	-0.161		-1.52
Zero Payment Indicator	-0.716	***	-10.55
Inclusive Value	0.147		0.38
Log Likelihood - Initial	-7186.5		
Log Likelihood - At Convergence	-5823.8		
Number of Observations	10368		
Percent Correctly Predicted	72.145		

Table 5.38: Buy/No Buy - Quarter 9

VARIABLE	COEFF.		T-STAT
Constant	-0.665	***	-3.20
Monthly Payment Amount	-0.008		-1.22
Monthly Payment Amount Squared	0.00004	*	1.81
Age Bracket 1	-0.062		-0.53
Age Bracket 2	-0.008		-0.10
Age Bracket 3	-0.045		-0.58
Age Bracket 5	0.153	*	1.68
Age Bracket 6	0.125		1.22
Income Bracket 1	0.236	***	2.64
Income Bracket 2	0.152	**	2.17
Income Bracket 4	-0.031		-0.39
Income Bracket 5	-0.135		-1.55
Model Children Present	0.147	**	2.36
Model Dwelling Unit Type	0.045		0.68
Model Marital Status	-0.021		-0.38
Model Housing Tenure	-0.113	*	-1.73
Telephone Indicator	-0.278	**	-2.15
Rural Route Indicator	0.042		0.46
Years as Customer	-0.372	***	-6.41
Years as Customer Squared	0.052	***	5.71
Years as Customer Cubed	-0.003	***	-5.25
Years as Customer Fourth Power	0.00005	***	4.92
Declining Balance 90 Days	-0.080	**	-1.96
Catalogs Sent	0.266	***	4.33
Catalogs Sent Squared	-0.037	***	-3.22
Catalogs Sent Cubed	0.002	***	2.84
Catalogs Sent Fourth Power	-0.00005	**	-2.46
Credit Orders Last 12 Months	0.114	**	2.02
Credit Orders Previous	0.009	***	3.02
Open Balance (000's)	0.316		0.94
Open Balance Squared (000's)	-0.058		-0.56
Zero Payment Indicator	-0.788	***	-10.41
Inclusive Value	0.775		1.53
Log Likelihood - Initial	-7325.2		
Log Likelihood - At Convergence	-6216.3		
Number of Observations	10568		
Percent Correctly Predicted	68.906		

Table 5.39: Dollars Purchased – Quarter 1

VARIABLE	COEFF.		T-STAT
Constant	-199.171		-1.49
Selection Correction – Buy	83.769	**	2.00
Monthly Payment Amount	1.148	*	1.95
Monthly Payment Amount Squared	-0.004	**	-1.97
Age Bracket 1	-23.624	*	-1.66
Age Bracket 2	-20.210		-1.62
Age Bracket 3	-5.037		-0.56
Age Bracket 5	-1.404		-0.14
Age Bracket 6	12.909		0.93
Income Bracket 1	9.875		0.89
Income Bracket 2	5.302		0.60
Income Bracket 4	9.393		0.85
Income Bracket 5	-6.740		-0.59
Model Children Present	27.439	***	3.20
Model Dwelling Unit Type	-11.324		-1.30
Model Marital Status	3.367		0.50
Model Housing Tenure	-0.619		-0.08
Telephone Indicator	-17.134		-1.19
Rural Route Indicator	-11.953		-1.00
Years as Customer	-25.094	*	-1.90
Years as Customer Squared	2.785		1.55
Years as Customer Cubed	-0.120		-1.25
Years as Customer Fourth Power	0.002		1.01
Declining Balance 90 Days	4.699		1.24
Catalogs Sent	46.514	*	1.86
Catalogs Sent Squared	-6.282		-1.62
Catalogs Sent Cubed	0.416		1.43
Catalogs Sent Fourth Power	-0.010		-1.29
Credit Orders Last 12 Months	13.950	**	2.02
Credit Orders Previous	0.291		0.66
Open Balance (000's)	32.902		0.74
Open Balance Squared (000's)	31.199		1.64
Zero Payment Indicator	3.847		0.39
Number of Observations	2040		
R-squared	0.06956		
Corrected R-squared	0.05473		

Table 5.40: Dollars Purchased – Quarter 2

VARIABLE	COEFF.		T-STAT
Constant	-346.328	*	-1.90
Selection Correction – Buy	128.366	*	1.87
Monthly Payment Amount	1.777	**	2.52
Monthly Payment Amount Squared	-0.012	***	-3.78
Age Bracket 1	29.898	*	1.89
Age Bracket 2	8.307		0.57
Age Bracket 3	20.655	**	2.07
Age Bracket 5	1.527		0.13
Age Bracket 6	-28.459	**	-2.02
Income Bracket 1	25.281	**	2.05
Income Bracket 2	6.989		0.76
Income Bracket 4	-12.042		-1.02
Income Bracket 5	-6.691		-0.52
Model Children Present	10.977		1.17
Model Dwelling Unit Type	-20.280	**	-1.97
Model Marital Status	-2.267		-0.24
Model Housing Tenure	17.176	*	1.90
Telephone Indicator	-26.227		-1.19
Rural Route Indicator	13.233		1.24
Years as Customer	-26.013	*	-1.83
Years as Customer Squared	3.268	*	1.72
Years as Customer Cubed	-0.155		-1.50
Years as Customer Fourth Power	0.002		1.28
Declining Balance 90 Days	2.759		0.63
Catalogs Sent	60.481	**	2.54
Catalogs Sent Squared	-7.604	***	-2.80
Catalogs Sent Cubed	0.471	***	2.80
Catalogs Sent Fourth Power	-0.010	***	-2.68
Credit Orders Last 12 Months	28.679	***	3.40
Credit Orders Previous	0.579		1.22
Open Balance (000's)	-43.898		-0.95
Open Balance Squared (000's)	136.386	***	5.67
Zero Payment Indicator	-19.397		-0.98
Number of Observations	2163		
R-squared	0.15162		
Corrected R-squared	0.13887		

Table 5.41: Dollars Purchased – Quarter 3

VARIABLE	COEFF.		T-STAT
Constant	14.176		0.18
Selection Correction – Buy	5.220		0.16
Monthly Payment Amount	1.037	**	2.52
Monthly Payment Amount Squared	-0.0002		-0.13
Age Bracket 1	16.918		1.38
Age Bracket 2	9.755		1.16
Age Bracket 3	3.643		0.49
Age Bracket 5	-11.434		-1.27
Age Bracket 6	-21.842	**	-2.08
Income Bracket 1	4.792		0.60
Income Bracket 2	6.591		0.98
Income Bracket 4	0.727		0.08
Income Bracket 5	-0.640		-0.07
Model Children Present	-5.082		-0.75
Model Dwelling Unit Type	-7.930		-1.13
Model Marital Status	-1.768		-0.30
Model Housing Tenure	-5.551		-0.79
Telephone Indicator	23.225	*	1.87
Rural Route Indicator	-3.528		-0.45
Years as Customer	-5.874		-0.75
Years as Customer Squared	1.113		0.95
Years as Customer Cubed	-0.073		-1.08
Years as Customer Fourth Power	0.001		1.14
Declining Balance 90 Days	0.354		0.11
Catalogs Sent	2.647		0.23
Catalogs Sent Squared	0.035		0.02
Catalogs Sent Cubed	-0.005		-0.05
Catalogs Sent Fourth Power	0.00002		0.01
Credit Orders Last 12 Months	6.861	**	2.05
Credit Orders Previous	-0.390		-1.38
Open Balance (000's)	20.967		0.59
Open Balance Squared (000's)	-16.807		-0.92
Zero Payment Indicator	11.879	*	1.78
Number of Observations	2959		
R-squared	0.0766096		
Corrected R-squared	0.0665110		

Table 5.42: Dollars Purchased – Quarter 4

VARIABLE	COEFF.		T-STAT
Constant	-81.110		-0.96
Selection Correction – Buy	37.537		1.38
Monthly Payment Amount	0.805	*	1.70
Monthly Payment Amount Squared	-0.005	***	-2.92
Age Bracket 1	6.005		0.41
Age Bracket 2	-15.117		-1.32
Age Bracket 3	7.523		0.85
Age Bracket 5	5.170		0.51
Age Bracket 6	3.723		0.33
Income Bracket 1	2.746		0.29
Income Bracket 2	-7.748		-0.94
Income Bracket 4	-12.441		-1.15
Income Bracket 5	5.060		0.42
Model Children Present	21.161	***	2.61
Model Dwelling Unit Type	-3.973		-0.46
Model Marital Status	8.918		1.29
Model Housing Tenure	-4.735		-0.59
Telephone Indicator	23.394		1.42
Rural Route Indicator	-4.562		-0.47
Years as Customer	-8.783		-1.19
Years as Customer Squared	1.351		1.13
Years as Customer Cubed	-0.077		-1.08
Years as Customer Fourth Power	0.001		1.04
Declining Balance 90 Days	11.630	***	3.00
Catalogs Sent	11.360		0.59
Catalogs Sent Squared	-4.921		-0.73
Catalogs Sent Cubed	0.898		0.88
Catalogs Sent Fourth Power	-0.046		-0.91
Credit Orders Last 12 Months	2.885		0.61
Credit Orders Previous	-0.217		-0.75
Open Balance (000's)	73.099	**	1.99
Open Balance Squared (000's)	32.105	**	2.13
Zero Payment Indicator	23.865	***	2.96
Number of Observations	2408		
R-squared	0.10400		
Corrected R-squared	0.0919312		

Table 5.43: Dollars Purchased – Quarter 5

VARIABLE	COEFF.		T-STAT
Constant	120.075		1.44
Selection Correction – Buy	-24.686		-0.81
Monthly Payment Amount	0.474		0.93
Monthly Payment Amount Squared	-0.005	**	-2.42
Age Bracket 1	19.725		1.31
Age Bracket 2	13.816		1.12
Age Bracket 3	8.120		0.83
Age Bracket 5	-24.462	**	-2.30
Age Bracket 6	-24.472	*	-1.93
Income Bracket 1	6.905		0.72
Income Bracket 2	5.220		0.65
Income Bracket 4	0.522		0.05
Income Bracket 5	24.302		1.60
Model Children Present	6.044		0.71
Model Dwelling Unit Type	-14.644	*	-1.68
Model Marital Status	1.100		0.15
Model Housing Tenure	20.458	**	2.53
Telephone Indicator	6.617		0.40
Rural Route Indicator	-3.845		-0.38
Years as Customer	-5.996		-0.69
Years as Customer Squared	1.255		0.98
Years as Customer Cubed	-0.079		-1.07
Years as Customer Fourth Power	0.002		1.09
Declining Balance 90 Days	5.963		1.51
Catalogs Sent	-16.814		-1.25
Catalogs Sent Squared	3.007		1.31
Catalogs Sent Cubed	-0.237		-1.42
Catalogs Sent Fourth Power	0.006		1.54
Credit Orders Last 12 Months	2.414		0.56
Credit Orders Previous	0.233		0.70
Open Balance (000's)	53.209		1.32
Open Balance Squared (000's)	35.612	*	1.89
Zero Payment Indicator	14.484	*	1.67
Number of Observations	2664		
R-squared	0.0619603		
Corrected R-squared	0.0505512		

Table 5.44: Dollars Purchased - Quarter 6

VARIABLE	COEFF.		T-STAT
Constant	141.211		1.11
Selection Correction - Buy	-38.142		-0.76
Monthly Payment Amount	-0.229		-0.37
Monthly Payment Amount Squared	-0.002		-0.81
Age Bracket 1	13.375		0.98
Age Bracket 2	18.317	*	1.78
Age Bracket 3	12.676		1.36
Age Bracket 5	3.755		0.38
Age Bracket 6	-3.169		-0.27
Income Bracket 1	-9.435		-0.77
Income Bracket 2	-1.188		-0.12
Income Bracket 4	-4.634		-0.41
Income Bracket 5	-10.044		-0.84
Model Children Present	6.309		0.79
Model Dwelling Unit Type	3.648		0.33
Model Marital Status	-1.304		-0.16
Model Housing Tenure	-12.860		-1.42
Telephone Indicator	9.676		0.59
Rural Route Indicator	-10.915		-1.16
Years as Customer	10.693		0.85
Years as Customer Squared	-1.879		-1.01
Years as Customer Cubed	0.116		1.15
Years as Customer Fourth Power	-0.002		-1.24
Declining Balance 90 Days	2.714		0.65
Catalogs Sent	-15.361		-1.12
Catalogs Sent Squared	2.351		1.11
Catalogs Sent Cubed	-0.165		-1.12
Catalogs Sent Fourth Power	0.004		1.12
Credit Orders Last 12 Months	-2.706		-0.40
Credit Orders Previous	0.052		0.18
Open Balance (000's)	132.61	***	3.52
Open Balance Squared (000's)	4.233		0.23
Zero Payment Indicator	17.069		1.34
Number of Observations	3036		
R-squared	0.0935401		
Corrected R-squared	0.0838808		

Table 5.45: Dollars Purchased – Quarter 7

VARIABLE	COEFF.		T-STAT
Constant	136.517		1.49
Selection Correction – Buy	-45.717		-1.16
Monthly Payment Amount	1.145	**	2.24
Monthly Payment Amount Squared	-0.003		-1.10
Age Bracket 1	17.866		1.31
Age Bracket 2	0.787		0.08
Age Bracket 3	-8.993		-1.00
Age Bracket 5	-11.097		-1.11
Age Bracket 6	-28.272	**	-2.49
Income Bracket 1	0.897		0.10
Income Bracket 2	1.234		0.16
Income Bracket 4	-2.631		-0.25
Income Bracket 5	-5.306		-0.46
Model Children Present	-3.653		-0.41
Model Dwelling Unit Type	-19.168	**	-2.35
Model Marital Status	17.915	**	2.49
Model Housing Tenure	-0.782		-0.10
Telephone Indicator	34.580	**	2.02
Rural Route Indicator	-5.896		-0.58
Years as Customer	-5.618		-0.72
Years as Customer Squared	0.835		0.71
Years as Customer Cubed	-0.044		-0.66
Years as Customer Fourth Power	0.0007		0.54
Declining Balance 90 Days	1.914		0.52
Catalogs Sent	1.636		0.20
Catalogs Sent Squared	-0.329		-0.32
Catalogs Sent Cubed	0.004		0.06
Catalogs Sent Fourth Power	0.0001		0.13
Credit Orders Last 12 Months	1.493		0.33
Credit Orders Previous	0.004		0.01
Open Balance (000's)	33.878		0.94
Open Balance Squared (000's)	2.800		0.17
Zero Payment Indicator	22.617	***	2.61
Number of Observations	3838		
R-squared	0.0842004		
Corrected R-squared	0.0764985		

Table 5.46: Dollars Purchased – Quarter 8

VARIABLE	COEFF.		T-STAT
Constant	196.475	**	2.30
Selection Correction – Buy	-80.685	*	-1.92
Monthly Payment Amount	-1.116	**	-2.43
Monthly Payment Amount Squared	-0.002		-1.23
Age Bracket 1	21.947		1.62
Age Bracket 2	26.065	**	2.25
Age Bracket 3	5.989		0.72
Age Bracket 5	2.336		0.23
Age Bracket 6	-10.612		-0.87
Income Bracket 1	-17.655	*	-1.74
Income Bracket 2	-17.275	**	-2.23
Income Bracket 4	15.937		1.56
Income Bracket 5	0.206		0.02
Model Children Present	-3.396		-0.42
Model Dwelling Unit Type	4.625		0.57
Model Marital Status	2.101		0.33
Model Housing Tenure	-10.114		-1.32
Telephone Indicator	10.812		0.69
Rural Route Indicator	1.811		0.18
Years as Customer	22.135	**	2.05
Years as Customer Squared	-3.189	**	-2.07
Years as Customer Cubed	0.161	*	1.95
Years as Customer Fourth Power	-0.003	*	-1.81
Declining Balance 90 Days	19.918	***	3.89
Catalogs Sent	-7.622		-0.85
Catalogs Sent Squared	0.957		0.46
Catalogs Sent Cubed	-0.109		-0.58
Catalogs Sent Fourth Power	0.003		0.64
Credit Orders Last 12 Months	-8.060		-1.36
Credit Orders Previous	-0.241		-0.90
Open Balance (000's)	142.07	***	4.88
Open Balance Squared (000's)	4.598		0.52
Zero Payment Indicator	79.196	***	2.83
Number of Observations	3208		
R-squared	0.11142		
Corrected R-squared	0.10247		

Table 5.47: Dollars Purchased – Quarter 9

VARIABLE	COEFF.		T-STAT
Constant	-163.067		-1.63
Selection Correction – Buy	92.344	*	1.72
Monthly Payment Amount	0.579		1.17
Monthly Payment Amount Squared	-0.005	***	-2.60
Age Bracket 1	11.780		0.77
Age Bracket 2	14.778		1.41
Age Bracket 3	16.260	*	1.72
Age Bracket 5	11.635		0.86
Age Bracket 6	-17.689		-1.24
Income Bracket 1	30.249	*	1.88
Income Bracket 2	23.217	**	1.99
Income Bracket 4	-11.315		-1.06
Income Bracket 5	-17.604		-1.29
Model Children Present	11.469		1.11
Model Dwelling Unit Type	-2.922		-0.35
Model Marital Status	8.971		1.25
Model Housing Tenure	-7.424		-0.84
Telephone Indicator	-2.479		-0.13
Rural Route Indicator	-12.738		-1.16
Years as Customer	-37.289	**	-2.04
Years as Customer Squared	5.113	*	1.95
Years as Customer Cubed	-0.258	*	-1.86
Years as Customer Fourth Power	0.004	*	1.79
Declining Balance 90 Days	-11.804	**	-1.97
Catalogs Sent	42.313	***	2.90
Catalogs Sent Squared	-5.857	***	-2.66
Catalogs Sent Cubed	0.333	**	2.37
Catalogs Sent Fourth Power	-0.006	**	-2.10
Credit Orders Last 12 Months	14.011	**	2.02
Credit Orders Previous	-0.014		-0.04
Open Balance (000's)	106.66	***	2.96
Open Balance Squared (000's)	6.173		0.50
Zero Payment Indicator	-53.314		-1.42
Number of Observations	3562		
R-squared	0.0614583		
Corrected R-squared	0.0529479		

Chapter 6 Discrete Time/Discrete Choice Duration Model

6.1 Introduction

This chapter introduces the dimension of time to the consumer's response. A discrete time/discrete choice model of consumer response is created using the the two exit reasons, time-varying covariates, and accommodations for those observations that are censored.[1] These models analyze consumers over a nine quarter time frame (March of 1992 through February of 1994), examining the impact of catalogs and the passage of time since the last purchase on the propensity to purchase. These models differ significantly from typical direct marketing models which segment consumers based on their demographics and the limited purchase history information in recency/frequency statistics. The models incorporate the number of purchase opportunities (promotions) a consumer receives, and optimizes the decision to purchase in a period given that those prior opportunities were ignored.

The marketing literature contains several studies of timing of purchase decisions covering different aspects of the purchase decision. Simonson [56] considers variety-seeking behavior by examining the relationship of acquisition and consumption of a

[1] Refer to Dubin and Rivers [12], Sueyoshi [61], and Wolf and Greenberg [66] for information on discrete time duration models.

product. In one case a consumer simultaneously purchases multiple products and consumes them sequentially; in the second they repeatedly acquire a single product and consume it prior to acquiring the second item. Anderson [2] analyzes repeat purchasing across product categories, finding that customers have a higher level of satisfaction with products than services, but have a lower repeat purchase likelihood for products. Rossi, McCulloch, and Allenby [53] examine the usefulness of purchase histories and find that they are useful in predicting subsequent purchases. In another study Rao and Steckel [50] employ a beta-logistic model to study the conditional probability of a positive response to a request for a club renewal, based on the number of prior requests.

Studies which assume that inter-purchase times as distributed as negative binomial, or a generalization of the NBD, include Ehrenberg [14], Morrison and Schmittlein [43] [44], Gupta and Morrison [20], and Rao and Steckel [50]. Hansotia [21] suggests estimating the number of offers before a consumer accepts a direct marketing offer as a logit. Wheat and Morrison [65] find that modeling purchase incidence is preferable to modeling inter-purchase time. Several other studies are based on either the proportional hazard model, or a variant of it, with continuous time. These include Jain and Vilcassim [25], Helsen and Schmittlein [23], Vilcassim and Jain [63].[2] Gupta [19] augments his analysis with the addition of marketing variables.

This analysis is based on discrete time/discrete choice duration models which estimate the optimal period for a consumer to exit. The discrete time version of the

[2]Vilcassim and Jain [63] employ a semi-Markov model reformulated as a proportional hazard model in continuous time.

hazard function is appropriate for mail order companies because the receipt of any given piece of promotional material elicits a response within a relatively short period of time. The consumer's decision is whether or not to purchase from the catalog (i.e., does the value of any product or group of products exceed their reservation price?). A less feasible alternative would be for the consumer to deliberate over the length of time between purchases. Therefore, rather than optimizing the inter-purchase time, the model determines the period with the optimal value of purchasing to the consumer.[3] A study that examines this problem from a different perspective, that of the acquiring names from various sources, is Wang and Splegel [64]. They examine customer retention issues and measure the contribution to margin of customers over time, relative to when and how the name was acquired.

6.2 A Model of Consumer Behavior

With the receipt of each piece of "junk mail" the consumer decides whether to purchase or not, given their current state. This implies that the consumer is faced with a discrete choice in a discrete time period. Prior studies of repeat purchases typically assume that the decision faced by the consumer is when to purchase the same item, or in the same product category, again. The mail order customer faces a different decision. They must simultaneously determine whether the value of any item exceeds its cost, and whether the costs of placing the order exceeds the benefits.

[3] Another notable difference between studying consumer response to mail order and many of the prior studies is that they focus on re-purchasing either the same product or within the same product class. In this analysis a second purchase, regardless of product class, is considered a re-purchase.

A complication in the case of mail order companies is that frequently the mailings of promotional materials occur in waves. Different groups of consumers may receive the same promotion at slightly different times. This allows for testing pull rates on specific offers and adjusting the list selection process. In addition, consumers that appear identical in many aspects may be selected to receive a different combination of offers in any given period.[4] Because of the staggered mailings and list selection process, this study concentrates on evaluating the purchase opportunities for a particular consumer in a given period.

In any given period, a consumer may place an order, do nothing, or, in a few cases, become non-promotable.[5] In this study we analyze a single spell of this duration model.[6]

The three discrete time/discrete choice duration models analyzed in this dissertation are depicted in the diagrams below. Before we build analytical models of each, the consumer's behavior should be described. In the time independent model, the consumer is only concerned with the the current period. It is based on the assumption that every period within an individual is independent of the choices made in every other period for the same individual. In the reservation value duration model, the

[4]The consumers in this study receive a combination of solos (single item offers), 8-prods (eight items in an envelope), 28-prods, catalogs, and multilogs (multiple catalogs bundled together). On average, these consumers received one hundred pieces of promotional material per annum from this single source.

[5]A consumer who is non-promotable will not receive future offers. In order to become non-promotable a consumer must not only be behind in their payments, but they must also have either not contacted customer service to renegotiate their payment schedule, or refused to do so when contacted by customer service. For the purposes of this analysis we have eliminated the choice of becoming non-promotable.

[6]Refer to Table A.6 for information on the frequency of exit by reason by period. In addition, the spell selected for this analysis is the most recent passage, i.e., the time between the most recent two orders.

error component of an individual's decision consists of two components – one specific to himself and constant over time, and the other independent across time periods and individuals. The nested duration model assumes that the individual know the expectation of their future periods given any choice – i.e., that they can predict their future circumstances if they order today versus not ordering.

Figure 6.1: Time Independent Duration Model

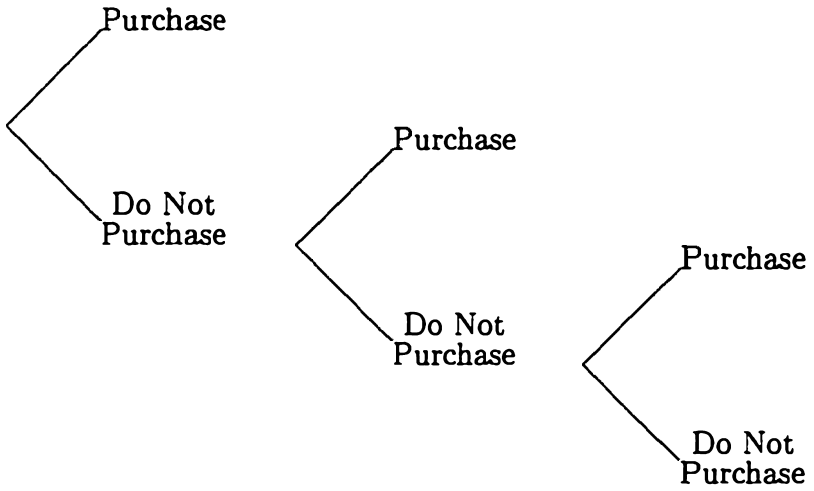


Figure 6.2: Reservation Value Duration Model

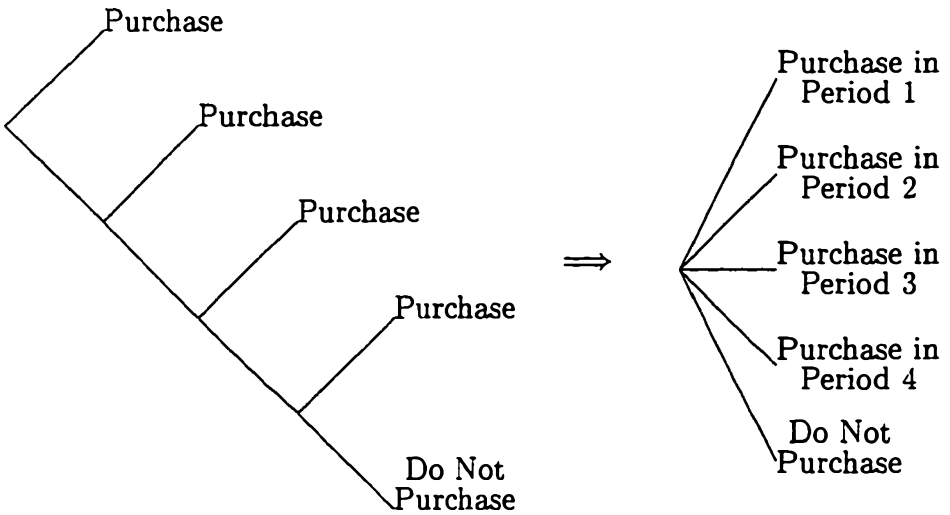
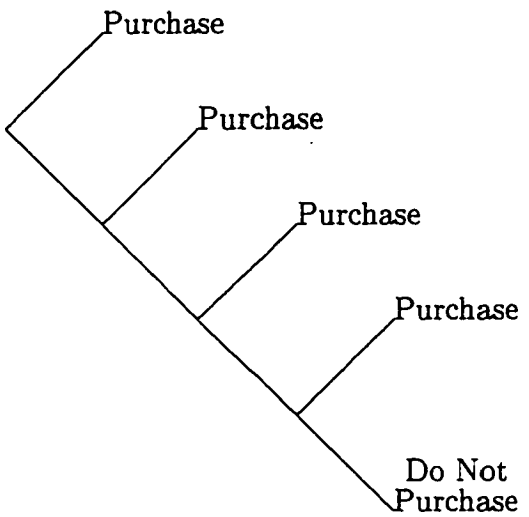


Figure 6.3: Nested Duration Model



6.3 Duration Models for Inter-Purchase Times

It is necessary to establish a protocol for selecting the transition to study. This analysis employs the "most recent passage," where the passage selected begins with an individual placing an order.[7] In addition, we require that an individual is on the database for the duration of the passage. This restriction primarily applies to inactive consumers who are re-activated following a significant period during which they did not receive promotions. There is an additional complicating aspect of the discrete time intervals. An individual can simultaneously order and become non-promotable in a single period. To resolve this "aliasing" effect the protocol must prioritize the events. We have given ordering precedence over non-promotable, for the purposes of determining the exit period. However, this is reversed for the determination of the entry period. Given these requirements a discrete time/discrete choice model for estimating inter-purchase times can be built.

6.4 Duration Model Notation

Let $U_{itk} = V_{itk} + \epsilon_{itk}$ where $i = 1, \ldots, N$ represents the consumers, $t = 0, 1, \ldots, T$ represents time periods, and $k = 0, 1, \ldots, J$ represents the choice set. For simplicity, assume a binary choice. Then Prob[exit in period s] = Prob[$U_{is1} > U_{is0}, U_{it1} < U_{it0}$ for all $t < s$].

[7]Note that the requirement to begin a passage on an order may be generalized.

6.5 Time Independent Duration Model

Assume $E[\epsilon_{itj}, \epsilon_{isj}] = 0$ for all $t \neq s$. Then

$$\text{Prob[exit in period } s] = (\prod_{t<s} \text{Prob}[U_{it1} < U_{it0}])\text{Prob}[U_{is1} > U_{is0}]. \tag{6.1}$$

6.6 Reservation Value Duration Model

Assume $U_{it0} = U_{i0}$ for all t. Therefore $U_{it0} = V_{it0} + \epsilon_{it0}$ can be simplified to $U_{i0} = V_{i0} + \epsilon_{i0}$, for all t. Then

$$\text{Prob[exit in period } s] = \text{Prob}[\max_{t<s}\{U_{it1}\} < U_{i0}, U_{is1} > U_{i0}]. \tag{6.2}$$

Two probabilities are required - that of not exiting prior to period s, and the probability of exiting in period s. We'll begin by defining the probability of not exiting prior to period s and then examining the the probability of exiting in period s in more detail.

The probability of not exiting prior to period s is:

$$\begin{aligned} \text{Prob[do not exit by period } s] &= \text{Prob}[U_{it1} < U_{it0} \text{ for all } t < s] && (6.3) \\ &= \text{Prob}[U_{it1} < U_{i0} \text{ forall } t < s], && (6.4) \end{aligned}$$

where this probability can be expressed as a multinomial logit:

$$\text{Prob[do not exit by period } s] = \frac{e^{V_{i0}}}{e^{V_{i0}} + \sum_{t<s} e^{V_{it1}}}, \tag{6.5}$$

assuming that the ϵ_{itk} are independent extreme value distributed. Similarly, the probability of not exiting by period $s-1$ can be expressed as

$$\text{Prob[do not exit by period } s-1] = \frac{e^{V}_{i0}}{e^{V_{i0}} + \sum_{t<(s-1)} e^{V_{it1}}}. \tag{6.6}$$

Note that the conditional probability of not exiting by period s, given not exiting by period $s-1$ is given by

$$\begin{aligned}
&\text{Prob[do not exit by } s | \text{do not exit by } s-1] \\
&\quad = \frac{\text{Prob[do not exit by } s \cap \text{do not exit by } s-1]}{\text{Prob[do not exit by } s-1]} \\
&\quad = \frac{\text{Prob[do not exit by } s]}{\text{Prob[do not exit by } s-1]} \\
&\quad = \frac{e^{V_{i0}} + \sum_{t\leq(s-1)} e^{V_{it1}}}{e^{V_{i0}} + \sum_{t\leq s} e^{V_{it1}}}.
\end{aligned} \tag{6.7}$$

The probability of exiting in period s, given not exiting by period $s-1$, can then be given by

$$\begin{aligned}
&\text{Prob[exit in period } s | \text{do not exit by } s-1] \\
&\quad = 1 - \text{Prob[do not exit by } s | \text{do not exit by } s-1] \\
&\quad = 1 - \frac{\text{Prob[do not exit by } s]}{\text{Prob[do not exit by } s-1]}
\end{aligned}$$

$$= \frac{(e^{V_{i0}} + \sum_{t \leq s} e^{V_{it1}}) - (e^{V_{i0}} + \sum_{t \leq (s-1)} e^{V_{it1}})}{e^{V_{i0}} + \sum_{t \leq s} e^{V_{is1}}}$$

$$= \frac{e^{V_{is1}}}{e^{V_{i0}} + \sum_{t \leq s} e^{V_{is1}}}. \tag{6.8}$$

6.6.1 Comparison to One-Factor Models

Here we demonstrate that the Reservation Duration Model given in equation (6.8) is in fact a one-factor model ([22] and [1]). Under the assumption of independent extreme value errors, the unconditional probability for the one-factor model is MNL.

The method of analysis derives the probability of purchase in an interval conditioned on the common latent factor. This latent factor is introduced into the model to account for unobserved heterogeneity. The unconditional probability results from integrating the conditional probability with respect to the distribution of the latent factor. Interestingly, in the case where all random variables are independent identically distributed extreme value the resulting unconditional probability is MNL. By contrast, in the more typical case of joint normality the one factor probability expression becomes an integral with respect to a normal density of the product of n cumulative normal distributions. The complexity of this latter integral has limited the usefulness of the one-factor model. Promising generalizations and solutions to the numerical problems associated with general factor models are being analyzed by Bayesian sampling techniques and Monte-Carlo integration. In the remaining portion of this section we will show that the one-factor model with extreme value errors is equivalent to the reservation value duration model.

In the reservation value duration model framework another expression for the

probability of purchasing at time t, given no prior purchases, is given by:

$$\begin{aligned}\text{Prob[action at time } t] &= \text{Prob}[V_{it1} + \epsilon_{it1} \geq V_{i0} + \epsilon_{i0} \\ &\quad \text{and } V_{is1} + \epsilon_{is1} \leq V_{i0} + \epsilon_{i0} \; \forall \, s \neq t, s \in T], \qquad (6.9)\end{aligned}$$

where $\epsilon_{it0} = \epsilon_{i0}$ for every $t \in T$. The conditional probability of purchasing at time t given that a purchase has not been made, is

$$P_t = \text{Prob}[V_{it1}+\epsilon_{it1} \geq V_{it0}+\epsilon_{i0} | V_{i11}+\epsilon_{i11} \leq V_{i10}+\epsilon_{i0}, \ldots, V_{i(t-1)1}+\epsilon_{i(t-1)1} \leq V_{i(t-1)0}+\epsilon_{i0}]. \qquad (6.10)$$

Heckman [22] and Amemiya [1] define a one-factor model where $\epsilon_{it} = \mu_{it} + \tau_i$. In the reservation duration model, the probability of no action by period t, conditional on an individual's ϵ_{i0} is given by:

$$\begin{aligned}&\text{Prob[Do Not Exit by Period } t | \epsilon_{i0}] \\ &\quad = \text{Prob}[\epsilon_{i1} \leq (V_{i0} - V_{i1}) + \epsilon_{i0}, \epsilon_{i2} \leq (V_{i0} - V_{i2}) + \epsilon_{i0}, \\ &\qquad \ldots, \epsilon_{it} \leq (V_{i0} - V_{it}) + \epsilon_{i0} | \epsilon_{i0}] \\ &\quad = \prod_{s=1}^{t} exp[-e^{-[V_{i0}-V_{is}+\epsilon_{i0}]}]. \qquad (6.11)\end{aligned}$$

To find the unconditional probability of no action by period t, the probability in equation (6.11) must taken over all possible values of ϵ_{i0}. Integrating over the density of ϵ_{i0} results in:

$$\begin{aligned}\text{Prob}[B_t] &= \text{Prob[Did Not Exit by Period } t] \\ &= \int \prod_{s=1}^{t} exp[-e^{-[V_{i0}-V_{is}+\epsilon_{i0}]}] f(\epsilon_{i0}) d\epsilon_{i0}\end{aligned}$$

$$
\begin{aligned}
&= \int \prod_{s=1}^{t} exp[-e^{-[V_{i0}-V_{is}+\epsilon_{i0}]}] exp[-e^{-\epsilon_{i0}}] e^{-\epsilon_{i0}} d\epsilon_{i0} \\
&= \int \prod_{s=0}^{t} exp[-e^{-[V_{i0}-V_{is}+\epsilon_{i0}]}] e^{-\epsilon_{i0}} d\epsilon_{i0} \\
&= \int exp[\sum_{s=0}^{t} -e^{-[V_{i0}-V_{is}+\epsilon_{i0}]}] e^{-\epsilon_{i0}} d\epsilon_{i0} \\
&= \int exp[\sum_{s=0}^{t} -e^{-\epsilon_{i0}} e^{-[V_{i0}-V_{is}]}] e^{-\epsilon_{i0}} d\epsilon_{i0}.
\end{aligned}
\tag{6.12}
$$

Let $\theta = \sum_{s=0}^{t} e^{-(V_{i0}-V_{is})}$. Then use the result that $\int e^{-\epsilon} exp[-\theta e^{-\epsilon}] d\epsilon = 1/\theta$, which follows from substituting $u \rightarrow -\theta e^{-\epsilon}$.

$$
\begin{aligned}
\text{Prob}[B_t] &= \text{Prob[Did Not Exit by Period } t\text{]} \\
&= \int exp[-e^{\epsilon_{i0}}\theta] e^{-\epsilon_{i0}} d\epsilon_{i0} \\
&= \frac{1}{\theta} \\
&= \frac{1}{\sum_{s=0}^{t} e^{-(V_{i0}-V_{is})}} \\
&= \frac{e^{V_{i0}}}{\sum_{s=0}^{t} e^{V_{is}}}.
\end{aligned}
\tag{6.13}
$$

Thus, the probability of action in period t is given by:

$$
P_{it1} = \frac{e^{V_{it}}}{\sum_{s=0}^{t} e^{V_{is}}}. \tag{6.14}
$$

Therefore, the reservation duration model is another expression for the one-factor model when assuming errors that are extreme value distributed.

6.7 Nested Duration Model

To simplify the exposition a two-period model is assumed in this analysis. However, the results may be extended to an N period model. Assume that the value received in the last period is defined as H_{is1} if the consumer purchases, and H_{is0} if no purchase is made. Similarly, in period $s-1$ the value received for purchasing is $H_{i(s-1)1}$. Then the strict utility for each state is

$$\begin{aligned} V_{i(s-1)1} &= H_{i(s-1)1} \\ V_{is1} &= H_{is1} + H_{i(s-1)0} \\ V_{is0} &= H_{is0} + H_{i(s-1)0} \end{aligned} \tag{6.15}$$

Further, if we assume that a correlation structure exists between the choices in period s that is from the generalized extreme value family, and that the correlation is σ, then the probability of exiting in period s, as derived by McFadden [40], is:

$$\text{Prob[exit in } s|\text{do not exit by } s-1] = \frac{e^{\frac{H_{is1}}{1-\sigma}}}{e^{\frac{H_{is1}}{1-\sigma}} + e^{\frac{H_{is0}}{1-\sigma}}}. \tag{6.16}$$

To estimate the probability of exiting in the first stage of the model, period $s-1$, the inclusive value must be computed. As defined by McFadden [40], the inclusive value is the maximum expected utility received from the second step and is given by:

$$I_{s-1} = \log[e^{\frac{H_{is1}}{1-\sigma}} + e^{\frac{H_{is0}}{1-\sigma}}]. \tag{6.17}$$

In addition, the probability of exiting in period $s-1$ is

$$\text{Prob[exit in } s-1] = \frac{e^{H_{i(s-1)1}}}{e^{H_{i(s-1)1}} + e^{H_{i(s-1)0}+(1-\sigma)I_{s-1}}}. \tag{6.18}$$

Another interpretation of the choices in period $s-1$ is that an individual who maximizes their utility will choose between

$$\tilde{V}_{i(s-1)1} = H_{i(s-1)1}, \tag{6.19}$$

and

$$\begin{aligned} \tilde{V}_{i(s-1)0} &= H_{i(s-1)0} + (1-\sigma) * I_{s-1} \\ &= H_{i(s-1)0} + (1-\sigma) * log[e^{\frac{H_{is1}}{1-\sigma}} + e^{\frac{H_{is0}}{1-\sigma}}]. \end{aligned} \tag{6.20}$$

Consider the following substitution:

$$1-\sigma = \frac{1}{1+r}, \tag{6.21}$$

where r is the interest rate between periods. Therefore, $r \geq 0$ implies that $1-\sigma \leq 1$ and $0 \leq \sigma \leq 1$.

In addition, consider the continuation value of the process at time $s-1$. It can be represented as the value received today plus the discounted value of future periods. In this case, the continuation value of not purchasing in period $s-1$ can be represented

by:

$$\tilde{V}_{i(s-1)0} = H_{i(s-1)0} + \frac{1}{1+r} * log[e^{(1+r)*H_{is1}} + e^{(1+r)*H_{is0}}]. \tag{6.22}$$

This is consistent with random utility maximization under the assumptions of a generalized extreme value distribution, i.e., a GEV with $1 - \sigma = \frac{1}{1+r}$.

McFadden [40] also notes that if H_s^* is the mean of H_{isk}, $\forall k \in J$, and not all $H_{isk} = H_s^*$, then

$$I_{s-1} = log[e^{\frac{H_{is1}}{1-\sigma}} + e^{\frac{H_{is0}}{1-\sigma}}] \geq \frac{H_s^*}{1-\sigma} + log(2), \tag{6.23}$$

where $H_s^* = \frac{H_{is1}+H_{is0}}{2}$ for the binary choice model. Then the strict utility at $s-1$ for not purchasing is bounded by

$$\begin{aligned} \tilde{V}_{i(s-1)0} &= H_{i(s-1)0} + (1-\sigma) * log[e^{\frac{H_{is1}}{1-\sigma}} + e^{\frac{H_{is0}}{1-\sigma}}] \\ &\geq H_{i(s-1)0} + (1-\sigma) * [\frac{H_s^*}{1-\sigma} + log(2)] \\ &= H_{i(s-1)0} + H_s^* + (1-\sigma) * log(2). \end{aligned} \tag{6.24}$$

6.8 Estimation Procedures

The following table lists the independent variables employed in the estimation of the duration models. The continuous portions of the time independent model and reservation value model were also estimated with these independent variables.[8] For

[8]The continuous portion of the nested logit model was not estimated since its selection correction term is identical to that for the time independent model.

the nested duration model two quarters were combined into semi-annual periods for the purposes of estimation. The nested duration model also requires estimating the open balance and promotional materials received for situations that did not arise. For example, if an individual did not purchase in period 1 then their estimated open balance is computed as the prior balance plus the average increase. This is required to estimate the inclusive values for the prior period.

Table 6.1: Independent Variables: Definitions

VARIABLE	DEFINITION
Time/Seasonality	
Spring	Months of March, April, and May
Fall	Months of September, October, and November
Winter	Months of December, January, and February
Beginning Quarter	Month of Entry to the Model - Captures Level Effects
Trend	Relative Month in Model - Captures Relative Effects
Budget Constraints	
Declining Balance	Credit History 90 Day Declining Balance Counter
Open Balance	ARCG Remaining Receivable Balance (in 000's)
Days Since Zero Balance	Days Since Last Zero Receivable Balance
Average Balance Last Six Mos.	Average Weekly Balance for Last Six Months
Promotional Materials	
No. of Solos	Number of Back-end Solos - Promotion Detail
No. of 8 Prods	Number of Back-end 8 Prods - Promotion Detail
No. of Catalogs	Number of Back-end Catalogs - Promotion Detail
Customer Characteristics	
New Customer	Profile Time As Customer Less Than One Year
Old Customer	Profile Time As Customer Greater Than Three Years
Telephone	Profile Indicator for Presence of a Telephone
Rural Route	Profile Indicator for Rural Route Address
Apartment	Profile Indicator for Residing in Apartment
Model Age	Six Age Brackets
Model Marital Status	Married is "1", Otherwise "0"
Model Children	Indicator for Presence of Children
Model Income	Five Income Brackets
Model Dwelling Type	Multiple is "0," Single is "1"
Model Housing Tenure	Rent is "0," Own is "1"
African-American	% of Population Reporting African-American - 90 Census
Latino-American	% of Population Answering Affirmative to Hispanic Origin - 90 Census
Over 65/Live Alone	% of Households with Person 65+ Living Alone - 90 Census
Single Female Household	% of Households Headed by a Single Female -90 Census

Chapter 7 Duration Model Hypotheses

Although the model contains information regarding consumer demographics, the focus of this analysis is to determine the effect of additional catalogs and the passage of time on the propensity to re-purchase. The hypotheses to be tested with this model are:

H1: an optimal number of catalogs exists such that the effect of additional catalogs on a consumer's propensity to purchase is negative

H2: the time since last purchase is positively correlated with a consumer's propensity to purchase

H3: the effect of catalogs on a consumer's propensity to purchase differs by season, with catalogs being the most effective during the holiday season, and,

H4: macro-economic effects and trends in retailing affect the propensity for a consumer to purchase from a catalog, and have a positive effect over absolute time.

In order to test the first two hypotheses a generalized polynomial expansion of the individual's utility function around the number of catalogs and time since the last purchase is required. Because consumers can be saturated with catalogs, to the point of being frustrated, there may be an optimal number of catalogs. This requires that the unknown utility function must be approximated by at least a third-order function.[1] Recall that V_{itk} represents the strict utility of the consumer. We can

[1] In addition, two fourth-order terms, (number of catalogs)^4 and (time since last order)^4, are also significant.

simplify V_{itk} to V_k at this point - the subscripts for the individual, i, and the time period, t, are implied in the following discussion. Therefore, V_k can be rewritten as:

$$\begin{aligned} V_k(X_i, Z_i, T_t) &= \alpha_k' X_i + \beta_k' Z_i + \delta' T_t \\ &= f(c, r) + g(q) + h(X_i, Z_i', T_t'), \end{aligned} \tag{7.1}$$

where $Z_i = (c, Z_i')$ and $T_t = (r, q, T_t')$, and c represents the number of catalogs received by the consumer in the current period, r is the number of periods since the consumer's last order, and q is the quarter, or physical period, that the consumer enters the model.[2] A third order Taylor Series expansion of $f(c, r)$ around an arbitrary point (c_0, r_0) is given by:

$$\begin{aligned} f(c,r) \approx\ & \frac{\partial f(c,r)}{\partial c}(c-c_0) + \frac{\partial f(c,r)}{\partial r}(r-r_0) + \\ & \frac{1}{2!}\left[\frac{\partial^2 f(c,r)}{\partial c^2}(c-c_0)^2 + 2\frac{\partial f(c,r)}{\partial c \partial r}(c-c_0)(r-r_0) + \frac{\partial^2 f(c,r)}{\partial r^2}(r-r_0)^2\right] + \\ & \frac{1}{3!}\left[\frac{\partial^3 f(c,r)}{\partial c^3}(c-c_0)^3 + 3\frac{\partial^3 f(c,r)}{\partial^2 c \partial r}(c-c_0)^2(r-r_0) + \right. \\ & \left. 3\frac{\partial^3 f(c,r)}{\partial c \partial r^2}(c-c_0)(r-r_0)^2 + \frac{\partial^3 f(c,r)}{\partial r^3}(r-r_0)^3\right], \end{aligned} \tag{7.2}$$

where the partial derivatives are evaluated at the point (c_0, r_0). After evaluating the partial derivatives and gathering the constants into one term, the function $f(c, r)$ may be re-written as:

$$f(c,r) \approx \text{constant} + \beta_1 c + \beta_2 c^2 + \beta_3 c^3 +$$

[2]Refer to Appendix A for a discussion of physical and logical quarters.

$$\mu_1 cr + \mu_2 c^2 r + \mu_3 cr^2 +$$

$$\delta_1 r + \delta_2 r^2 + \delta_3 r^3. \tag{7.3}$$

The coefficients $\beta_1, \beta_2, \beta_3, \mu_1, \mu_2, \mu_3, \delta_1, \delta_2$, and δ_3 can then be estimated by a maximum likelihood procedure.

The first two hypotheses can then be re-written as:

H1′: $\partial f(c, r|r)/\partial c$ equals zero at some positive number of catalogs, given r, and $\partial^2 f(c, r|r)/\partial c^2$ is negative.

H2′: for a given value of c, $\partial f(c, r|c)/\partial r$ is positive, or at least non-negative. However, there are no restrictions on the sign of $\partial^2 f(c, r|c)/\partial r^2$.

The first hypotheses can then be tested directly by evaluating the functions:[3]

$$\frac{\partial f(c, r|r)}{\partial c} = \beta_1 + 2\beta_2 c + 3\beta_3 c^2 + \mu_1 r + 2\mu_2 cr + \mu_3 r^2 \tag{7.4}$$

$$\frac{\partial^2 f(c, r|r)}{\partial c^2} = 2\beta_2 + 6\beta_3 c + 2\mu_2 r \tag{7.5}$$

for each value of r, $r = 1, 2, \ldots, 8$.

In a similar manner, the second hypothesis is tested by evaluating the functions:

$$\frac{\partial f(c, r|c)}{\partial r} = \mu_1 c + \mu_2 c^2 + 2\mu_3 cr + \delta_1 + 2\delta_2 r + 3\delta_3 r^2 \tag{7.6}$$

$$\frac{\partial^2 f(c, r|c)}{\partial r^2} = 2\mu_3 c + 2\delta_2 + 6\delta_3 r \tag{7.7}$$

[3]Note that for the first two hypothesis we are only required to optimize over one variable at a time. For example, in hypothesis 1, the problem is to optimize c, given r. Since we are not restricted to sending out catalogs in only one period, the problem becomes one of finding the optimal number of catalogs for every period. In a similar fashion the second hypothesis also reduces to a problem in one dimension, time since the last order. Although it is not of interest, it would be possible to optimize $f(c, r)$ over both c and r.

for various numbers of catalogs received each period.

The third hypothesis can be tested by inspecting the coefficients of the variables Spring * No. of Catalogs, Fall * No. of Catalogs, and Winter * No. of Catalogs. The omitted season is Summer. Our goal is to determine not only in which seasons are catalogs more effective, but also how much more effective.

The effect of absolute time can be seen through the function $g(q)$, which is approximated by a fourth order Taylor Series expansion around the point q_0:

$$g(q) \approx \frac{\partial g(q)}{\partial q}(q-q_0)+\frac{1}{2!}\frac{\partial^2 g(q)}{\partial q^2}(q-q_0)^2+\frac{1}{3!}\frac{\partial^3 g(q)}{\partial q^3}(q-q_0)^3+\frac{1}{4!}\frac{\partial^4 g(q)}{\partial q^4}(q-q_0)^4, \quad (7.8)$$

where the derivatives are evaluated at q_0. Rearranging terms and aggregating all the constants into one term, the function $g(q)$ may be re-written as:

$$g(q) = \text{constant} + \delta_4 q + \delta_5 q^2 + \delta_6 q^3 + \delta_7 q^4. \quad (7.9)$$

Using this formulation the fourth hypothesis may be re-written as:

H4′: $\partial g(q)/\partial q$ is positive for the range of beginning quarters considered in the analysis, where $\partial g(q)/\partial q = \delta_4 + 2\delta_5 q + 3\delta_6 q^2 + 4\delta_7 q^3$.

Chapter 8 Discrete Duration Model Results

First we should note that all models are consistent with stochastic utility maximization, which implies that all the models are rational, i.e., that the consumers are rational. In addition, all the models are nested within a class of models. The time independent model is a special case of the nested model which limits a customer's view to the current period. This can be accomplished through the assumption of a high discount rate with devalues all future events. The reservation value duration model is also a special case of the nested duration model which considers historical periods at the same time as the current period. The nested duration model allows the consumer to consider future periods, given certain assumptions regarding his expected income, etc.

In the next sections we will consider the hypotheses proposed in the prior chapter, list the results of the estimation, and briefly investigate alternative catalog policies and the method for investigating such hypothetical situations.

8.1 Hypothesis Testing for the Time Independent Duration Model

The preliminary results, before considering the amount purchased, indicate that to maximize the propensity to purchase, each customer should receive approximately

eleven catalogs in the period following an order.[1] Refer to the Figure below for the graph of the terms involving the term "catalog." A curve for each of the first six periods is shown. In the second period following an order, the optimal number increases to about fifteen. At subsequent periods, the propensity to repurchase has decreased to the point where the optimal number of catalogs exceeds twenty per thirteen week period.

The results of testing the second hypothesis suggest that with the passage of time since the last order, given that the number of catalogs received per period is constant, there is an increased propensity to purchase. Figure 5.3 demonstrates this effect for the a constant number of catalogs per period, with curves drawn for 4, 10, and 16 catalogs per quarter.[2]

The analysis of the effectiveness of catalogs by season has predictable results. Catalogs received in the quarter beginning in December are the most effective, followed by those received from September through November. [3] The effectiveness of catalogs received from March through May does do not differ from those received from June through August, with both quarters being less effective than those prior to or during the holiday season.

The results of testing the fourth hypothesis indicate that for this company's cus-

[1] Refer to Table 5.2 for detailed results.

[2] Note that the "mean" pattern of catalogs given that a consumer has not exited the model is 10, 9, 8, 8, 9, 8, 8, and 4. Refer to the Table A.9 for additional information.

[3] The difference in the coefficients for Fall and Winter was tested using an alternate model specification. That model verified that the effectiveness of Winter catalogs is statistically greater than that of Fall catalogs.

Figure 8.1: Effect of Catalogs

□ 1 Period; △ 2 Periods; ◯ 3 Periods; * 4 Periods; + 5 Periods; □ 6 Periods

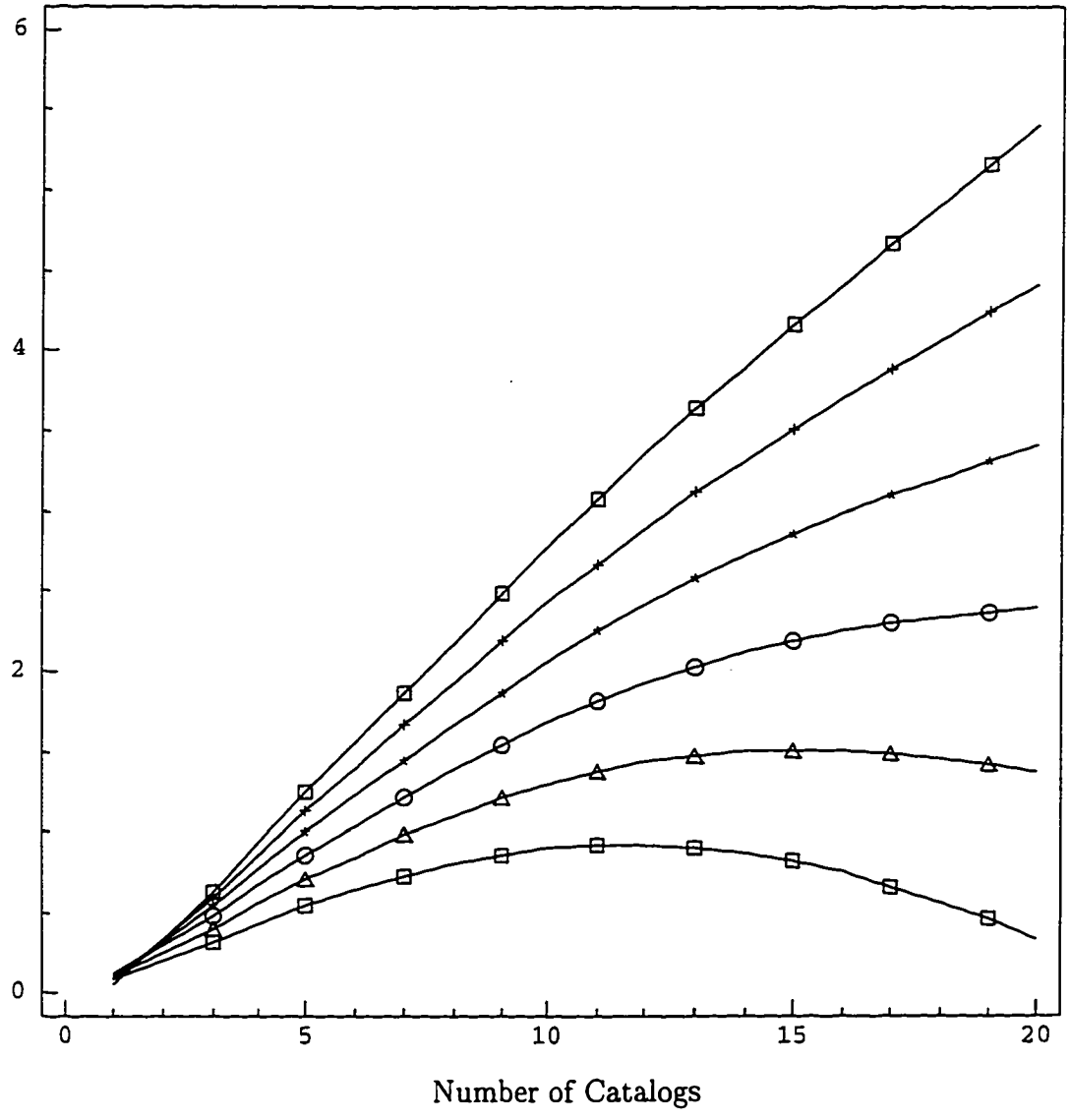
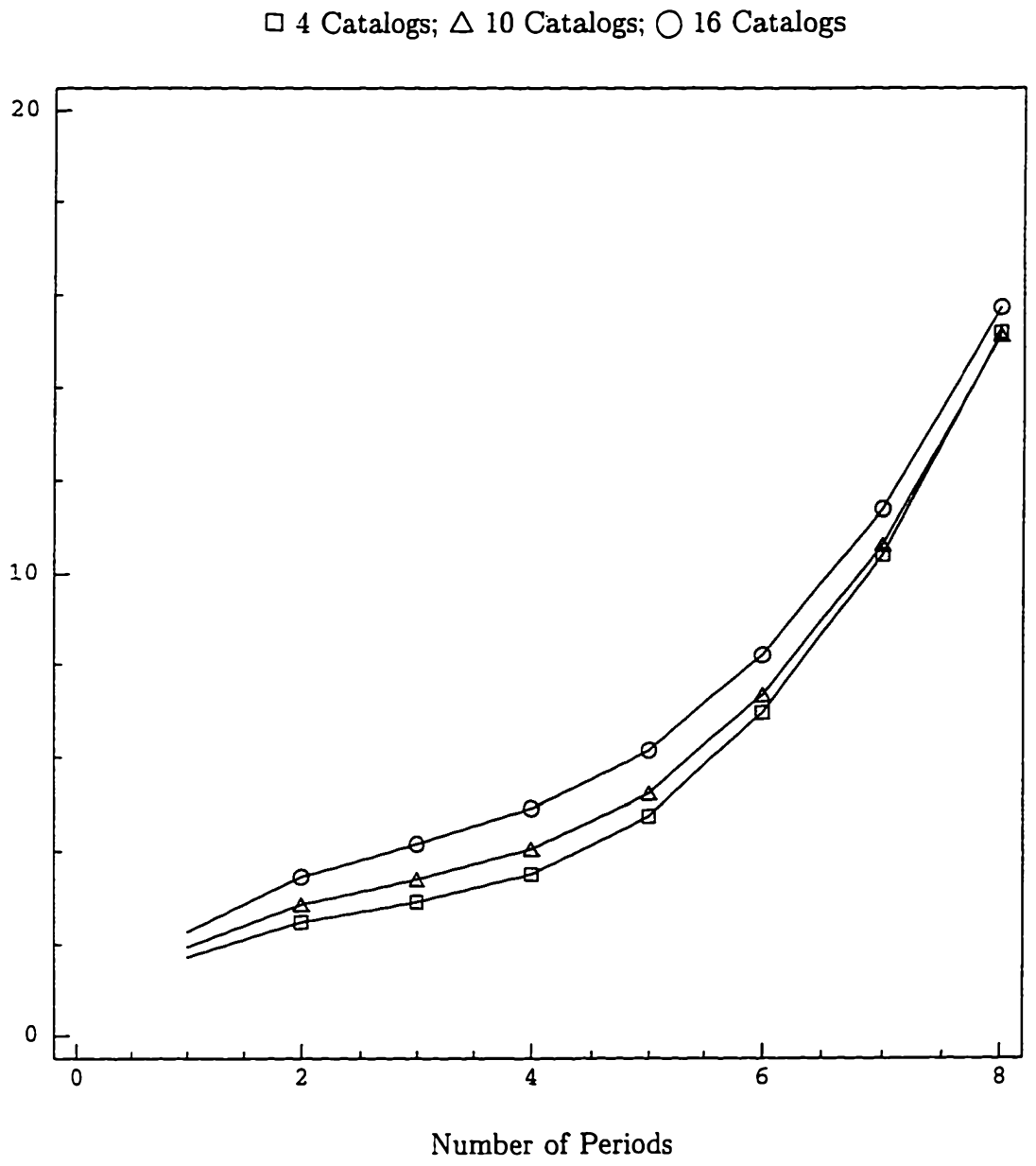


Figure 8.2: Effect of Time Since Last Purchase



tomers, the propensity to purchase from their catalogs is increasing over time. Refer to the figure below. Note that the company being studied allows consumers to pay for their purchases over time with a fixed-end agreement. Because the company specifically targets low to middle income individuals with this type of financing, this result may reflect either a down-turn in the economy, and hence credit-tightening elsewhere in the market, or simply an increasing trend in catalog purchasing.

8.2 Tables

Figure 8.3: Effect of Absolute Time

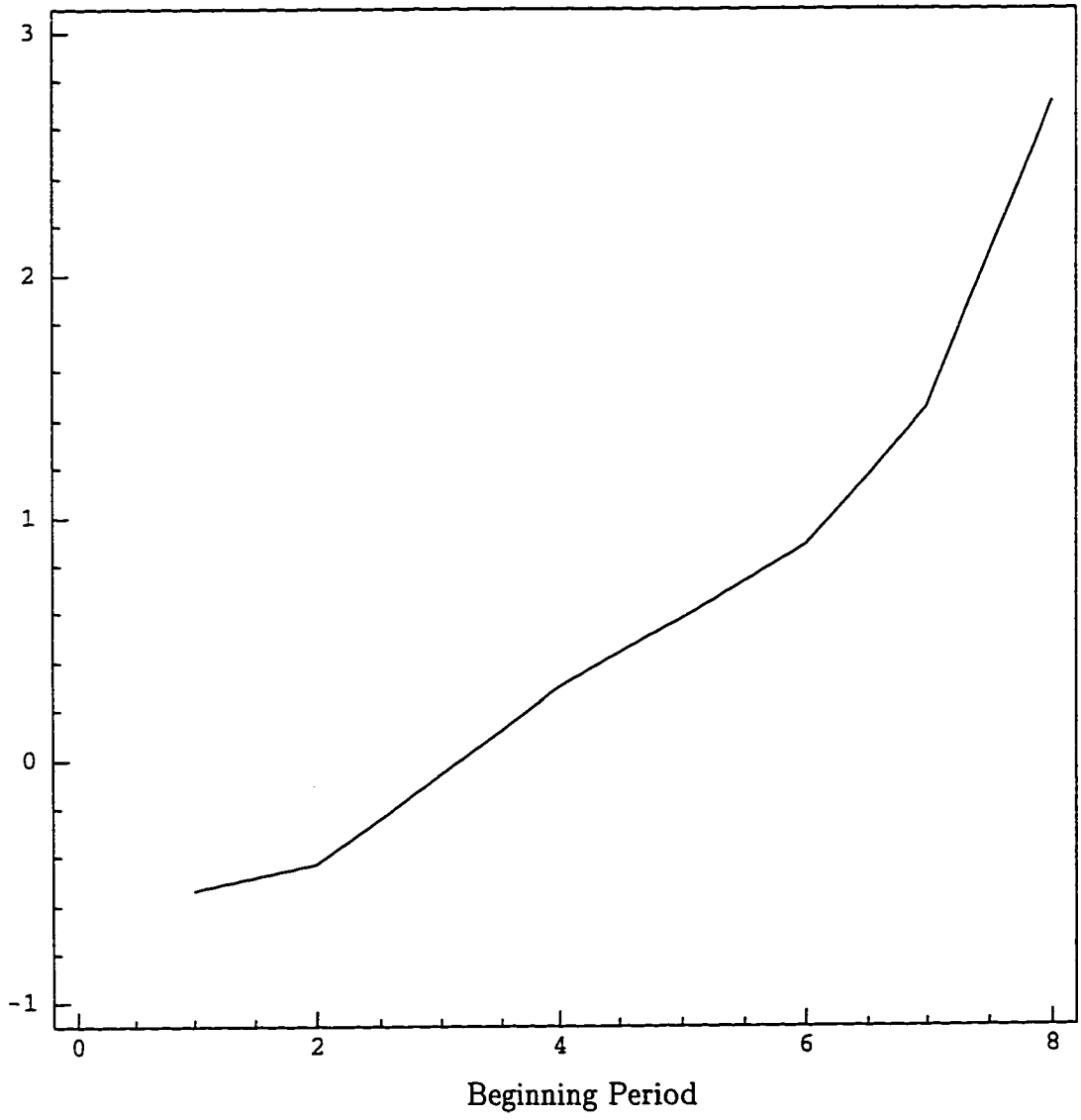


Table 8.1: Time Independent Duration Model

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	-2.931	-8.66
Time/Seasonality		
Fall Quarter	-0.138	-1.79
Beginning Quarter	-1.687	-4.75
Beginning Quarter^2	1.043	6.38
Beginning Quarter^3	-0.213	-7.18
Beginning Quarter^4	0.015	8.33
Trend	1.718	4.95
Trend^2	-0.834	-4.86
Trend^3	0.148	4.37
Trend^4	-0.008	-3.74
Budget Constraints		
Declining Balance	0.076	4.01
Open Balance (10^-3)	1.608	11.36
Open Balance^2 (10^-3)	-0.0003	-5.10
Trend * Open Balance	-0.0002	-4.18
Promotional Materials		
Number of Catalogs	-0.229	-4.94
Number of Catalogs^2	0.016	2.18
Number of Catalogs^3	-0.0009	-1.89
Number of Catalogs^4	0.00002	2.47
Trend * Catalogs	0.137	15.15
Trend * Catalogs^2	-0.002	-7.32
Trend^2* Catalogs	-0.012	-10.81
Spring * Catalogs	0.011	2.72
Fall * Catalogs	0.071	10.82
Winter * Catalogs	0.042	5.74
Customer Characteristics		
New Customer	0.415	7.78
Old Customer	-0.354	-10.23
Apartment	-0.188	-3.21
Model Age	0.033	2.98
Model Income	-0.058	-5.04
Model Housing Tenure	-0.087	-2.43
Percent Latino-American	-0.002	-2.83
Initial Log Likelihood	-27330	
Log Likelihood at Convergence	-17287	
Number of Observations	16283	

Table 8.2: Reservation Value Duration Model

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	-3.230	-7.90
Time/Seasonality		
Fall Quarter	0.676	9.63
Winter Quarter	-0.241	-2.54
Beginning Quarter	-1.615	-2.97
Beginning Quarter^2	1.052	4.20
Beginning Quarter^3	-0.204	-4.50
Beginning Quarter^4	0.013	4.63
Trend	-0.558	-16.09
Budget Constraints		
Declining Balance	0.306	16.66
Open Balance (10^{-3})	3.315	15.73
Open Balance^2 (10^{-6})	-0.692	-6.78
Trend * Open Balance	-0.002	-12.22
Trend^2 * Open Balance (10^{-3})	-0.103	4.50
Trend * Open Balance^2 (10^{-6})	0.338	7.80
Promotional Materials		
Number of Catalogs	0.310	7.71
Number of Catalogs^2	-0.050	-8.82
Number of Catalogs^3	0.003	9.20
Number of Catalogs^4 (10^{-2})	-0.475	-7.47
Trend * Number of Catalogs	0.118	19.58
Trend * Number of Catalogs^2	-0.004	-17.47
Spring * Number of Catalogs	-0.017	-4.84
Fall * Number of Catalogs	-0.044	-7.16
Winter * Number of Catalogs	-0.130	-10.81
Customer Characteristics		
New Customer	0.609	9.70
Old Customer	-0.680	-13.95
Telephone	1.125	9.88
Model Age	0.092	4.83
Model Children	0.287	5.73
Model Income	-0.059	-3.64
Model Dwelling Unit Type	0.215	4.01
Percent African-American	0.003	3.14
Percent Single Female Head of Household	0.017	6.15
Initial Log Likelihood	-34177	
Log Likelihood at Convergence	-17067	
Number of Observations	16476	
Percent Correctly Predicted	56.045	

Table 8.3: Nested Duration Model

Second Period/No Purchase in First

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	-2.095	-12.06
Budget Constraints		
Declining Balance	0.249	5.72
Open Balance	0.003	3.90
Days Since Zero Balance	-0.0006	-5.72
Average Balance Last Six Months	-0.002	-3.83
Promotional Materials		
Number of Catalogs	0.075	18.06
Customer Characteristics		
New Customer	1.844	2.26
Model Age	0.089	3.49
Model Children	0.229	3.19
Model Income	-0.113	-5.06
Percent Over 65 Living Alone	0.006	1.41
Initial Log Likelihood	-5335.2	
Log Likelihood at Convergence	-4224.9	
Number of Observations	7697	
Percent Correctly Predicted	71.924	

Table 8.4: Nested Duration Model

Second Period/Purchased in First

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	-2.395	-15.76
Budget Constraints		
Declining Balance	0.077	2.18
Open Balance	0.0003	1.63
Days Since Zero Balance	-0.0002	-2.06
Average Balance Last Six Months	0.0004	1.99
Promotional Materials		
Number of Catalogs	0.098	27.19
Customer Characteristics		
Old Customer	-0.240	-3.91
Rural Route	-0.141	-1.64
Model Age	0.192	7.57
Model Children	0.210	3.14
Model Income	-0.043	-1.98
Percent Latino-American	-0.002	-1.74
Initial Log Likelihood	-5439.8	
Log Likelihood at Convergence	-4664.9	
Number of Observations	7848	
Percent Correctly Predicted	67.661	

Table 8.5: Nested Duration Model

First Period

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	-0.745	-7.17
Budget Constraints		
Declining Balance	0.290	11.48
Open Balance	0.001	5.01
Days Since Zero Balance	-0.0003	-4.41
Average Balance Last Six Months	0.0006	3.05
Promotional Materials		
Number of Catalogs	0.027	5.04
Customer Characteristics		
New Customer	0.982	14.84
Old Customer	0.154	3.39
Model Age	0.036	2.03
Model Children	0.088	1.85
Model Income	-0.153	-10.53
Percent African-American	0.001	2.08
Inclusive Value	0.753	15.34
Initial Log Likelihood	-10300	
Log Likelihood at Convergence	-9453.6	
Number of Observations	14860	
Percent Correctly Predicted	63.466	

8.3 Hypothetical Catalog Policies

In this section we analyze the propensity to purchase over an array of policies dictating how many catalogs per quarter a consumer would receive.[4] The profile of a typical individual will be used to compare the effectiveness of the current practice of catalog distribution with those of varying levels. The mean number of catalogs per quarter, given that a customer ordered again this period is 10, 9, 8, 8, 9, 8, 8, and 4 for the eight quarters studied.[5] This policy will be contrasted with various alternatives which employ a more diverse sequence in terms of the number of catalogs per quarter.

The typical consumer selected for this analysis has been a customer for more than two years. They have a telephone, live in their own home in an urban area, are approximately 40 years of age, married, and have children. Their annual income is slightly below $25,000. They currently have an open balance of $150, which is their average amount open, and they are 30% paid on open items. A typical consumer can be assume to live in an average neighborhood with the population mean percentages of African-Americans, Latino-Americans, people over 65 living alone, and single female heads of households. Because the primary focus is to ascertain the effect of catalogs, the number of solos and 8-prod received per period by the consumer will be set to zero. Let the date be March 1, 1992, the first period of the model.

The policies under consideration are summarized in the Table below. The first policy is simply the current mean of catalogs sent, given that the consumer did not

[4]This analysis employs a three choice model with No Purchase, Purchase, and Bad Debt/Not Promotable as the choices. Bad Debt/Not Promotable was introduced in this model so the probability of entering that state could be compared with purchasing.

[5]Refer to Table A.9, Independent Variable Means by Period, for additional information.

already re-purchase. The second policy is to send every consumer a specific number of catalogs every period. The third and fourth are variations that reduce the number of catalogs in the periods immediately following a purchase, increase, and then decrease. The difference between the policies is the relative number before and after the peak. The third policy, low-high-medium, places less emphasis on the period immediately following the purchase relative to the fourth policy, medium-high-low. The fifth policy is a strictly decreasing quantity of catalogs, whereas the sixth is a strictly increasing quantity of catalogs.

Table 8.6: Hypothetical Catalog Policies

	CUR.	CONST.	L-H-M	M-H-L	DEC.	INC.
1	10	10	4	10	16	2
2	9	10	4	10	14	4
3	8	10	4	10	12	6
4	8	10	16	16	10	8
5	9	10	16	16	8	10
6	8	10	10	4	6	12
7	8	10	10	4	4	14
8	4	10	10	4	2	16

The probabilities that our consumer purchases at least once in a given time period are given in the Table below. With a constant number of catalogs the peak probability occurs in the fourth period. In addition, the peak probability is higher in the policies that vary the number of catalogs than it is in the constant number of catalogs strategy. The effect of an additional catalog in the second period is striking when comparing the current strategy with that of constant numbers of catalogs.

Table 8.7: Probabilities by Period by Policy

	CUR.	CONST.	L-H-M	M-H-L	DEC.	INC.
Unconditional Probability of Purchase						
1	0.145	0.145	0.022	0.145	1.000	0.018
2	0.159	0.262	0.044	0.262	0.000	0.044
3	0.102	0.223	0.043	0.223	0.000	0.069
4	0.116	0.187	0.879	0.369	0.000	0.168
5	0.112	0.069	0.000	0.000	0.000	0.259
6	0.060	0.044	0.000	0.000	0.000	0.353
7	0.040	0.023	0.000	0.000	0.000	0.077
8	0.008	0.012	0.000	0.000	0.000	0.001
Unconditional Probability of Non-promotable ($x10^{-3}$)						
1	0.009	0.009	0.008	0.009	0.000	0.009
2	1.194	0.700	9.948	0.700	0.000	9.994
3	0.349	0.133	1.910	0.133	0.000	0.887
4	0.002	0.000	0.000	0.000	0.000	0.003
5	0.001	0.000	0.000	0.000	0.000	0.001
6	0.005	0.000	0.000	0.000	0.000	0.000
7	0.015	0.002	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000

There are additional assumptions required prior to computing the value to the firm of this consumer. We would need to assume a cost of carrying the open receivable, say 8% per annum. In the future, if the data is available, the marginal cost of sending each additional catalog to a customer should be considered in the analysis. The average cost for each catalog as recorded in the promotion detail file is \$0.25 for this period, although this number varies depending on the catalog. The typical catalog is approximately 100 pages in length. The companies planning horizon would also need

to be assumed, say one year, or four periods.[6]

Within the range of catalogs we are considering, the more catalogs received by consumer, in any period, the higher the NPV. Another way to analyze the problem is to examine the NPV per catalog.

An important point is that this analysis assumes that the order size is equal, regardless of the inter-purchase time. Because our consumer is probably credit constrained, this assumption may not be plausible. We must consider the possibility that the consumer is optimizing the period in which to order as well as the purchase amount.

8.4 Possible Extensions to Analysis of Hypothetical Catalog Policies

This analysis could be extended to include an optimization of the firm's profit and the marginal rate of substitution between catalogs this period and next period. The Lagrangian for the four period problem with the catalog expenditures held constant becomes:

$$\begin{aligned} L \;=\; & P_{i11}(c_1) + P_{i21}(c_2)\frac{(1 - P_{i11}(c_1) - P_{i12}(c_1))}{(1+r)} + \\ & P_{i31}(c_3)\frac{(1 - P_{i11}(c_1) - P_{i12}(c_1))(1 - P_{i21}(c_2) - P_{i22}(c_2))}{(1+r)^2} + \\ & P_{i41}(c_4)\frac{(1 - P_{i11}(c_1) - P_{i12}(c_1))(1 - P_{i21}(c_2) - P_{i22}(c_2))(1 - P_{i31}(c_3) - P_{i32}(c_3))}{(1+r)^3} + \end{aligned}$$

[6]Note that this analysis could be augmented to consider the cost of writing off bad debt and returns.

$$\lambda(c_0 - \sum_{t=1}^{4} \frac{c_t}{(1+r)^{t-1}}), \tag{8.1}$$

where c_t is the number of catalogs received in period t, P_{it1} is the probability of individual i ordering in period t given that they have not yet exited, P_{it2} is the corresponding probability of exiting on becoming non-promotable, c_0 is a constant level of expenditure, and r is the quarterly rate of return, or interest rate. Theoretically, in a two-period model the marginal rate of substitution, or $\partial c_2/\partial c_1$, should be negative and equal to $(1+r)$. The effective rate of return on the firm's capital (i.e., the trade-off in sending catalogs this period versus next) can then be solved for using the first-order conditions. This rate can then be compared across alternative catalog policies. The functions (P_{it1} and P_{it2}) and their derivatives will be evaluated empirically in order to solve for r.

8.5 Discussion and Conclusion

The findings in this chapter are important to the direct marketing industry and in particular, to mail order firms. We have demonstrated not only that the relationship between the number of catalogs sent to a consumer and their purchase behavior is not linear, but also that the timing of the catalogs relative to their last purchase is important. Understanding this interaction between the number of catalogs sent and the passage of time may provide two benefits to a firm. First, they can potentially reduce the number of promotions sent to a consumer immediately following a purchase. Although the firm does need to maintain a presence in the consumer's home,

they may be able to minimize the number of catalogs sent during that time. A second benefit is in understanding that when the time is "right" to purchase, that there is an optimal number of promotions to send a consumer.

To illustrate the impact of these findings, we will consider a situation similar to the one facing the company studied in this analysis. Let's assume that the pull rate for a given general merchandise catalog will range from somewhere over two percent to as high as eight percent.[7] If the company send out multiple promotions in a given quarter, some consumers will place more than one order. Therefore, if we assume ten mailings in the quarter, the percentage of consumers ordering at least once may be as high as 25%.[8]

For the company employed in the analysis, a 0.1% increase in pull is equivalent to adding $1 million to the bottom line.[9] The significance in terms of profitability is not to be understated. A firm such as this one would consider equally the effort required to increase revenues by an amount to generate an additional million dollars of profit, and the effort required to reduce expenditures by a million dollars.

Future substantive research in this area should consider an analysis of those customers paying cash versus those opting to use the company's credit. In addition, from a technical perspective, forward versus backward spells (i.e., durations, or time between events) should be analyzed. Although the durations computed for this analysis

---

[7]Although a response rate range with a high of eight percent may appear low, it is in fact fairly high for many direct marketing companies. Many offers elicit response rates around two percent.

[8]Refer to Tables C.3 and C.4. If we make a very optimistic assumption that the marketing orders counted in Table C.3 are the result of catalogs, then the response rate for consumers receiving catalogs (found in Table C.4) is 27% for the quarter beginning December, 1993.

[9]Recall that this company is one of the largest mail order firms in the United States. Smaller firms will have proportionately smaller dollar volumes, but perhaps the same relative impact to their profitability.

were backwards from the last order placed, it should also be possible to estimate models from a beginning period forward. Last, estimating purchase propensity by product category and for branded versus non-branded goods should be investigated. This may assist in the identification of additional market segments and in the personalization of the catalogs.

Chapter 9 Duration/Continuous Model – Theory

9.1 Introduction

Existing discrete/continuous models examine the impact that changes in the probability of an event occurring, or a choice being observed, have on the revenue generated or amount consumed. In some cases, such as travel mode decisions, the primary focus is on estimating the number of individuals selecting a particular choice. In other situations, such as estimating revenue derived from an activity or event in a particular time period, the continuous amount is of primary interest. By varying the timing of an event, or by influencing the probability an event occurs, the policy maker also influences the associated expected revenue. This chapter analyzes the impact of various marketing strategies on consumer response and the corresponding revenue forecasts for a direct marketing company. The marketing strategy influences both the probability of purchase and the amount of the purchase through the number and frequency of promotional materials sent to a household.[1]

[1]The consumers in this study receive a combination of solos (single item offers), 8-prods (eight items in an envelope), 28-prods, catalogs, and multilogs (multiple catalogs bundled together). On average, these consumers received one hundred pieces of promotional material per annum from this single source.

9.2 Continuous Model Notation

The continuous model can represent either an amount consumed or an amount generated by the individual or agent. If the process is an expenditure model, then the relevant amount is the amount consumed or spent. The process may also be a revenue generating function. In both cases let the relevant amount for individual i at time t be given by:

$$D_{it} = R_{it1}\gamma + \eta_{it}, \tag{9.1}$$

where R_{it1} is the set of factors, as previously described, which influence the amount. Since the amount is only observed for individuals who act, we allow for correlation between η_{it} and the unobserved factors which affect the timing of the choice. Thus, equation (9.1) may be rewritten as:

$$D_{it} = R_{it1}\gamma + \mathrm{E}[\eta_{it}|\text{Choice is } k] + \upsilon_{it}, \tag{9.2}$$

where υ_{it} is uncorrelated with the purchase decision. In general, ordinary least squares applied to equation (9.2) will yield consistent estimates of the structural parameters γ. The next three sections will discuss the estimate of $\mathrm{E}[\eta_{it}|\text{Choice is } k]$, where k represents the appropriate choice in each model. We pursue the selection correction method to obtain consistent estimates of the parameters. Thus, we find the conditional expectation of the equation error given all the information regarding the selection and include this conditional expectation as an additional factor in the regression. It is also possible to estimate this equation consistently using instrumental variables or reduced form techniques (refer to Dubin and McFadden [11]). These are

discussed below.

9.3 Time Independent Duration/Continuous Model

The choice made by the individual in the time independent model is $k = 0$ or $k = 1$, where each period is an independent event. In that case equation (9.2) simplifies such that:

Proposition 1 *Suppose that each period is an independent event and the duration is modeled by the time independent model. Then in the binary model*

$$E[\eta_{it}|(\epsilon_{i10}, \epsilon_{i11}, \epsilon_{i20}, \epsilon_{i21}, \ldots, \epsilon_{iT0}, \epsilon_{iT1})] = E[\eta_{it}|(\epsilon_{it0}, \epsilon_{it1})] \tag{9.3}$$

The selection correction term(s) are then given by:

$$E[\eta_k|\textit{Choice is } k] = \frac{\sqrt{6}\sigma}{\pi}\left[\sum_{j=1}^{m} R_j \frac{P_j}{(1-P_j)} \ln P_j - R_k \frac{\ln P_k}{(1-P_k)}\right], \tag{9.4}$$

where P_k represents P_{itk}, R_k is the correlation between η_{it} and ϵ_{itk}, and σ is the standard error of the continuous equation error, η_k.

For the proof of this proposition, refer to Dubin and McFadden [11].

The two-step estimation process proceeds in a manner similar to that for discrete/continuous models. First the time independent duration model is estimated. Then given the probabilities of actions $k = 0, 1, \ldots, m$ are computed and used to calculate the selection correction terms. Last, the continuous equation is estimated by incorporating the selection correction terms as additional explanatory variables in the model.

9.4 Reservation Value Duration/Continuous Model

For any sets A, B, and C such that $A \cup B = C$ and $A \cap B = \phi$, the "law of total expectations" implies:

$$\mathrm{E}(Z|C) = \mathrm{E}(Z|A)P(A|C) + \mathrm{E}(Z|B)P(B|C). \tag{9.5}$$

Let

$$\begin{aligned} A_t &= \text{exit in } t \\ B_t &= \text{do not exit by } t \\ C_t &= B_{t-1} = \text{do not exit by } t-1. \end{aligned}$$

In addition, let $Z = D_{it}$, the amount consumed. Since

$$\text{Prob[exit in } t \cup \text{do not exit by } t] = \text{Prob[do not exit by } t-1], \tag{9.6}$$

and

$$\text{Prob[exit in } t \cap \text{do not exit by } t] = \phi, \tag{9.7}$$

it follows that

$$\begin{aligned} \mathrm{E}(\eta_{it}|\text{do not exit by } t-1) &= \mathrm{E}(\eta_{it}|\text{exit in } t)\text{Prob[exit in } t|\text{do not exit by } t-1] \\ &+ \mathrm{E}(\eta_{it}|\text{do not exit by } t) \cdot \\ &\quad \text{Prob[do not exit by } t|\text{do not exit by } t-1]. \end{aligned} \tag{9.8}$$

In addition, since an individual must either act or continue,

$$\text{Prob[exit in } t|\text{do not exit by } t-1] =$$

$$1 - \text{Prob[do not exit by } t|\text{do not exit by } t-1]. \tag{9.9}$$

Therefore,

$$\text{E}(\eta_{it}|\text{exit in } t) =$$

$$\frac{\text{E}(\eta_{it}|\text{no exit by } t-1) - \text{E}(\eta_{it}|\text{no exit by } t)\text{Prob[no exit by } t|\text{no exit by } t-1]}{1 - \text{Prob[no exit by } t|\text{no exit by } t-1]}. \tag{9.10}$$

This leads to the next proposition:

Proposition 2 *Assume that η_{it} conditional on $\tilde{\epsilon} = \{\epsilon_{i0}, \epsilon_{i11}, \ldots, \epsilon_{it1}\}$ has a linear conditional expectation which depends only on the difference $(\epsilon_{it1} - \epsilon_{i0})$. Thus,*

$$E[\eta_{it}|(\epsilon_{i0}, \epsilon_{i11}, \epsilon_{i21}, \ldots, \epsilon_{iT1})] = R(\epsilon_{it1} - \epsilon_{i0}), \tag{9.11}$$

where R measures the correlation between ϵ_{it1} and η_{i0}. The selection correction term we obtain is given by:

$$E(\eta_{it}|A_t) = \left(\frac{Q_{t-1}\ln Q_{t-1} - Q_t \ln Q_t - Q_t[R_t/(1-R_t)]\ln R_t}{Q_{t-1} - Q_t}\right) * (\lambda R), \tag{9.12}$$

where $Q_t = Prob[do\ not\ exit\ by\ t]$.

The proof of this proposition is given in Appendix C. Note that the selection correction term is again a function of probabilities and correlations, similar in nature to that given by Dubin and McFadden [11].

9.5 Nested Duration/Continuous Model

In the nested duration model the disturbances of interest are $\tilde{\epsilon}_{it0}$ and ϵ_{it1}. If we assume that η_{it} is a function of difference of those disturbances, then reinterpretating the results of Dubin and McFadden [11], it follows that:

Proposition 3 *Assume that the duration process is modeled by the nested duration model. Further assume that* $E[\eta_{it}|(\epsilon_{i11}, \epsilon_{i21}, \ldots, \epsilon_{iT1}, \epsilon_{iT0})] = R(\epsilon_{it1} - \tilde{\epsilon}_{it0})$. *Then the selection correction term(s) are identical to those given for the time independent model, with estimation proceeding by period.*

Chapter 10 Duration/Continuous – Results

The first table below presents the results of the continuous dollar amount for the time independent duration model and the second table those for the continuous dollar amount for the reservation value duration model. In both cases the selection correction terms are statistically significant. Note that for the three-choice discrete/continuous model, the mean impact of the selection correction term is 35% of the mean amount purchased, or $ 79.56, in the quarter beginning December, 1993. Not only is the coefficient statistically significant, but the inclusion of the appropriate selection correction terms can have a significant dollar impact on the estimate of dollars purchased. In addition, in both cases the relative and absolute time affect the amount purchased, implying that both the year, the season, and the time since last purchase are important determinants in a consumer's decision of how much to purchase. The budget constraint explanatory factors, open balance and the declining balance count, are also significant and as such play a role in determining the dollar value of the purchase. Last, preferences, proxied by the customer characteristics, impact the dollar value of the purchases.

The time independent model was executed such that separate selection correction terms were included for each time period. Note the difference in magnitude of the coefficients for period 1 versus periods 2 through 6, and period 7. A query of the customer open balances reveals that those exiting in period 7 have low open balances,

i.e., appear to paying off their balance, when they purchase again. This signals another type of customer segmentation – those willing to incur "revolving" charges and those desiring a zero balance before placing subsequent orders.

A comparison of the two models reveals that both have "low" R^2, but they do identify significant factors in the dollar amount decision. Although only the time independent model was executed with period-specific correlations, it is possible to execute both models in this fashion. This particular empirical investigation indicates that failure to account for the effect of unobserved correlation between errors in the amount purchased and the purchase decision can lead to inaccurate scoring of customers and inaccurate forecasts of total demand and revenue.

Table 10.1: Continuous/Time Independent Model

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	246.538	3.86
Time/Seasonality		
Fall Quarter	-12.176	-1.35
Winter Quarter	-16.201	-1.39
Beginning Quarter	-268.840	-3.45
Beginning Quarter^2	157.922	4.57
Beginning Quarter^3	-34.657	-5.73
Beginning Quarter^4	2.539	6.99
Budget Constraints		
Declining Balance	9.798	2.81
Open Balance	0.212	13.92
Open Balance^2 (10^3)	-0.010	-1.27
Customer Characteristics		
Old Customer	-16.027	-2.64
Telephone	28.389	1.53
Model Age	-17.219	-8.53
Model Marital Status	19.634	3.58
Model Housing Tenure	-20.908	-3.31
Percent African-American	0.359	3.55
Percent Over 65 Living Alone	-2.013	-3.34
Percent Single Female HH	1.059	2.09
Selection Correction Terms		
Selection Correction	59.953	10.27
Selection Correction * Exit in 2	-64.942	-15.62
Selection Correction * Exit in 3	-52.846	-10.38
Selection Correction * Exit in 4	-53.111	-9.16
Selection Correction * Exit in 5	-50.869	-7.32
Selection Correction * Exit in 6	-42.474	-4.72
Selection Correction * Exit in 7	-28.820	-2.36
Number of Observations	13229	
R-squared	0.17592	
Corrected R-squared	0.17443	

Table 10.2: Continuous/Reservation Value Model

INDEPENDENT VARIABLE	EST. COEFF.	T-STAT
Constant	885.225	17.73
Time/Seasonality		
Fall Quarter	23.956	3.77
Trend	-957.69	-13.52
$Trend^2$	404.56	11.18
$Trend^3$	-69.59	-9.67
$Trend^4$	4.166	8.589
Budget Constraints		
Percent Paid	0.161	1.864
Declining Balance	6.336	1.683
Open Balance	0.521	11.70
Open $Balance^2$ (10^{-3})	-0.005	-3.05
Trend * Open Balance	-0.284	-7.156
$Trend^2$ * Open Balance	0.044	6.563
Trend * Open $Balance^2$ (10^{-3})	0.003	2.465
Customer Characteristics		
Old Customer	-15.35	-2.53
Telephone	31.866	1.71
Model Age	-18.549	-9.22
Model Marital Status	21.820	3.97
Model Dwelling Unit Type	-12.244	-1.55
Model Housing Tenure	-11.146	-1.52
Percent African-American	0.349	3.45
Percent Over 65 Living Alone	-1.964	-3.26
Percent Single Female HH	1.054	2.07
Conditional Expectation of η_i	6.088	1.91
Number of Observations	13210	
R-squared	0.18760	
Corrected R-squared	0.18625	

Chapter 11 Discussion and Conclusion

The first results shared with the company included the fact that the selection correction term is statistically significant and accounts for a substantial percentage of the purchase amount. This implies that correcting for the bias in the error term due to the simultaneous decisions to purchase and how much to purchase is important for both scoring customers and forecasting total demand and revenue for a given promotion. The company employed in this analysis is aware of this finding, but is probably not a good test case for this particular model.

Another important finding for the company, and others in direct marketing, is that linear probability models ranked customers differently than logit models. Although this requires additional research, the impact of this finding will be far-reaching - the vast majority of research in direct marketing employs OLS. Again, the company studied is aware of a very preliminary execution of this test, but was not committed to performing any further analysis or testing in this area.

From the duration models, we found that the number of catalogs and their timing impact the propensity of a customer to purchase. This implies that various hypothetical catalog policies should be investigated further and tested in the market place. The practice of sending the same set of promotions to almost all customers is not necessarily cost effective.

The continuous models related to the duration models also provide insight into

potential segmentation strategies. Direct marketers frequently segment their customers recency, frequency, and monetary value (RFM). It appears that past payment patterns and purchase patterns may be linked for some individuals. If the customers who payoff their balances before purchasing another item can be identified, then that attribute should be used in a segmentation scheme.

There were also several difficulties in completing a dissertation project such as this. The most basic problem is access to the data. While that was accomplished, in part, the company was not as forthcoming regarding the data and their use of it as would have preferred. Although we selected the initial number of customers to extract (the 50,000 on May 1994), the number of data elements per customer per quarter is larger than originally anticipated – there are over 2200 variables per customer per quarter, in addition to the transaction (order detail and promotion detail) related data. This lead to difficulties in determining which of N similar data elements best represented various attributes, such as a customer's income or age. Therefore, due to the volume of data and its complexity, assumptions were made which may have affected the substantive results. For example, rather than determine which of a large number of income fields best describes the current household income, we used the " model" income as defined by the company. This income is an income bracket based on a series of inquiries they program against many income-related fields. They were not willing to share the process of determining which income fields were "better" than others, resulting in our use of their summary income brackets.

11.1 Future Research

Additional research should be completed on both direct marketing and duration model areas. Related technical topics include extensions to continuous time, extensions to normal errors (i.e., probit models, multinomial probit, Gibbs sampling, etc.), model replacement and goodness of fit measures, and generalized correction structures between time periods and between the discrete choice model and the continuous regression. In addition, because direct marketers typically use regression to score their customers, it is important to continue investigating when the differences in ranking occur between regressions and discrete choice models.

There are also several areas of consumer response to direct marketing that should be evaluated further. They include:

- Long-Run versus Short-Run Effects
- Compulsive Buyers
- Holiday-Only Buyers
- Mail-Stream Management and Saturation
- List Management Implications
- Cohort Analysis
- Customer Service Implications
- Prediction of Frequency - Lifetime and Recent
- Branded Goods versus Private Label

A more detailed outline of future work can be found in Appendix B.

Appendix A Micro-level Data

A.1 Introduction

This dissertation employs a unique dataset from one of the largest mail order firms in the United States. Their business is comprised of several units, including "base" business,[1] "new" business,[2] joint ventures, an info-merical business, and periodically, a TV shopping channel. Within base business consumers are brought through a process which moves them from the "front-end" of the business to the "back-end." Front-end customers are those that respond to single-item offers in several media, e. g., solos and newspaper adds. After a customer has successfully paid for progressively more expensive items on a time basis, they become "middle-end" customers. Following additional levels of success, a customer becomes a back-end customer. The list containing millions of back-end customers is the master list used in the segmentation process for any given mailing.

The data extraction process for this analysis began with selecting 50,000 individuals who were active customers in May, 1994. The 50,000 customer accounts were randomly selected from the approximately thirteen million accounts active at that

[1]Base business consists of general merchandise promotions targeted to lower and middle income consumers. Items are offered for both a cash price, and under fixed-end credit terms from the company. In effect, the mail order company acts as a finance company for this group of customers.

[2]New business targets middle to upper income individuals, with offers of higher-end merchandise such as electronics and computers, and operating on a cash or credit card basis.

time.[3] The historical customer account records for the 50,000 customers were then extracted on a quarterly basis beginning in March of 1992. Refer to Table A.1 for the number of active accounts by quarter. The increase in customers from March of 1992 to May of 1994 reflects additions to the list of active customers. The decrease from May of 1994 to June of 1995 is attributed to customers no longer being considered active, and hence, no longer receiving promotions. Since the purpose of this analysis is to analyze the effects of promotions on customer behavior, the loss of those customers does not affect the analysis. In addition, occasionally a customer will be either in-active or non-promotable.[4] These customers then leave the active customer list and will not re-appear until their account is cleared or they place another order.[5]

There are several types of data available for every customer. First, a current customer database record, with up to 2200 variables, is available for the beginning of every quarter. This file contains their credit applications, order summary information, payment histories, and other socioeconomic variables. The company's information is

[3]The company retains information on approximately 30 million households in the United States. Of those, about 13 million are considered active – having ordered in the last four years. Once a week a series of large samples is drawn from this active population. There are both 1-in-10 and 1-in-100 samples drawn for use in the marketing research department. The sample of 50,000 customers used in this analysis is a random sample from the 1-in-10 random sample of active customers. The same 50,000 customers were then extracted in thirteen week intervals prior to and after the initial sample. A total of thirteen quarters has been extracted, although this analysis only uses nine quarters of the data.

[4]A consumer who is non-promotable will not receive future offers. In order to become non-promotable a customer must not only be behind in their payments, but they must also have either not contacted customer service to renegotiate their payment schedule, or refused to do so when contacted by customer service. A customer may also become non-promotable if they are suspected of fraudulent activity or return items on a frequent basis.

[5]Refer to Table A.9, Independent Variable Means by Period, for the average number of promotions received by customer, given that they have not ordered in N periods. Note that even a customer who has not ordered in two years receives, on average, four catalogs in a quarter. Therefore, in order for a customer to become in-active from not ordering, and therefore cease to receive catalogs, a significant amount of time must have passed since their last order.

Table A.1: Number of Customer Accounts by Quarter

QUARTER	NUMBER OF CUSTOMER ACCOUNTS
March 1992	20,666
June 1992	21,734
September 1992	23,328
December 1992	25,224
March 1993	27,076
June 1993	29,725
September 1993	33,828
December 1993	39,503
March 1994	44,971
May 1994	50,000
June 1994	48,308
September 1994	43,269
December 1994	37,687
March 1995	33,358
June 1995	29,935

supplemented by third party data collected by the firm. A second source of data is the file of actual customer orders. It contains a record for every product ordered by every customer for the period covered in the analysis. The third data source is the detailed promotion file, with one record per piece of promotional material sent to each customer during this time. A fourth source will be the customer service records for the 50,000 individuals. Brief descriptions of each data source are given below.

A.2 Current Customer Database

The customer database is actually a composite of many data files, each containing a single record per customer. All active customers eligible to receive promotions are included in the database. Since the database is an evolving company asset, the segments contained on the database vary over time. However, a number of segments exist for a majority of the quarters being analyzed. The frequency of a segment existing for a particular customer depends on its origin. The internal segments exist for every customer for every quarter. Some external, or third party, data is available for some, but not all, customers in select quarters. Below is a brief description of each major data segment within the customer database. An Entity Relationship Diagram for the company data is at the end of this appendix.

- Customer Attributes (internal) – in addition to customer name and address information, this segment contains summary order information such as the number of products ordered and returned, and the associated total dollars, by product class.

- R. L. Polk (external) – includes select census data elements plus detailed information on the number, body size, and market value of passenger cars and trucks by residence. This data has been matched by address to customers.

- Promotion History (internal) – the number of promotions by type (solo, 8-prods, multi-mailers, catalogs, and multi-logs) by prior periods (1-7 months, 8-13 months, 14-25 months, 26-37 months, and 38-49 months).

- Composite Lifestyle (external) – contains age and sex information by household. Also includes marital status, length of residence, and dwelling unit type.

- Credit History (internal) – records a summary information on a customer's payment history, including the number of days since last payment, the amount, their balance, and the number of days delinquent. In addition, statistics such as the maximum, average for last six months, and number of occurrences of the payments and delinquent amounts are tracked.

- 1990 Census of Population and Housing (external) – a third-party provides the matching process for adding STF3A data to each customer. The data is matched at the lowest feasible level based on available address information (for example, block or block group in an urban area).

- Names Master (internal) – contains indicators for list sources. Since the lists vary by quarter and are unidentified, it is of limited value for analysis.

- Birthday Club (internal) – the company offers "free gifts" on a customer's birthday. This segment also records the names, sex, and ages of other members of

the household, extended to include grandchildren.

- Survey (internal) – records the results of internal company surveys of its customers. Summary data regarding the number of surveys sent, returned, their type, and number of days to return, are recorded for each customer. In addition, detailed questions indicating levels of interest in various product categories are recorded from the most recent survey.

- Preference Database (internal) – another source of company survey results, from select customers for specific surveys, such as first time buyer's survey and a re-activation survey.

- Add-On (internal) – contains summary information on customer service outbound calls to the customer. The offers include extended warranties for recently ordered/purchased electronics, furniture for the same, etc. A customer's response statistics, including the number of sales/no sales and total minutes on the phone, by period, by quarter, by year, by weekday, by time of day, etc.

- Non Add-On (internal) – records information on other customer service outbound calls. Offers include rebates, sweepstakes, duns cross in the mail, and other offers. Also includes the response statistics by type of offer, time period, etc.

- Inbound (internal) – statistics on when the customer calls the company. Summary data on when they call (day of week, time of day, month, recency), how many are for orders, how long the phone calls are, etc., are maintained.

- ACRC (internal) – contains credit extract information, including the open receivable balance, days past due, and percent paid.

- Demographics (external) – contains the Donnelley 1980 census data.

- Middle-End (internal) – records first purchase information for middle-end customers, including the product class, price, and media. Summary statistics are also kept on the number of orders placed, cancelled orders, and time as middle-end customer

One additional file by customer by quarter has been provided. It includes the model scores computed by the company for every customer. The values include customer age, household income, gender, presence of children, rent or own indicator, credit risk, return propensity, generic response code, Latino indicator, marital status, credit card ownership, and dwelling unit type. Many of these values are the value given on customer's credit application or returned on a survey. For unknown fields, a predicted value based on a regression against known customer attributes and those of other company customers is employed.

A.3 Order Detail

The order detail file contains one record for every product ordered, shipped, or cancelled by a customer. Although it does not contain detailed information on the premiums (free gifts) sent with an order, the number of such gifts is recorded. For the two year period beginning March 1, 1992, there were 298,148 items shipped to

the customers being studied. This represents a smaller number of marketing orders, as shown in Table A.2.[6]

Table A.2: Marketing Orders by Quarter

QUARTER	NUMBER OF MARKETING ORDERS
March 1992	8369
June 1992	9104
September 1992	13962
December 1992	10164
March 1993	11567
June 1993	13092
September 1993	19434
December 1993	13844

In addition to the product code, the order detail file contains the promotion associated with the order, a cash/credit indicator, a service/warranty indicator, shipping and handling charges (order level), finance charges (order level), information on days pending due to credit and inventory availability, an inbound telemarketing indicator, base price, and product family/department/group information.

A.4 Promotion Detail

Every piece of mail sent to every customer is tracked in a promotion detail file. It contains the sales project, side, and list for each piece of "junk mail." The combination

[6]The order detail records have been aggregated to marketing orders, where a marketing order is the order as placed by the customer. A marketing order may be split into several shipping orders depending on product availability and size constraints.

of these three fields identifies a unique offer. Also included on the file is the mail date, the media codes, the company code, and the advertising cost associated with this particular piece of mail. The first character of the media code identifies the media group, such as back-end, Birthday Club, a Thank You, re-activation, or a bangtail. The second digit represents the type, such as a solo (single product offer), an 8-prod (eight products mailed in a single envelope), a multi-mailer (up to 28 products mailed together), a catalog, or a multi-log. The total number of back-end promotions sent to the selected customers is given in Table A.3. In addition, the number and fraction of customers receiving the promotions are also given.

Table A.3: Promotions by Quarter

TYPE	MAR92	JUN92	SEP92	DEC92	MAR93	JUN93	SEP93	DEC93
Total Number Sent								
Solos	34386	13585	41413	20057	38820	10234	58663	47398
8-Prods	21922	28305	35411	28422	22713	38107	40746	28572
Multi-Mailers	30559	22417	40192	30155	41128	37813	47360	44953
Catalogs	147208	148875	194717	113279	174951	214209	313327	178619
Multi-logs	11050	12425	12937	22361	13963	13721	29662	17052
Number of Customers Receiving Each Type								
No. of Customers	20666	21734	23328	25224	27076	29725	33828	39503
Solos	13266	7890	14295	9595	13655	6998	16493	22925
8-Prods	10247	13912	12949	14839	12505	16349	15221	14397
Multi-Mailers	10765	9805	12127	11098	16656	17459	18603	19308
Catalogs	18482	18832	21033	21627	24336	26271	28619	29762
Multi-logs	10655	11985	12021	14189	13624	13621	17985	16930
Fraction of Customers Receiving Each Type								
Solos	64.2	36.3	61.3	38.0	50.4	23.5	48.8	58.0
8-Prods	49.6	64.0	55.5	58.8	46.2	55.0	45.0	36.4
Multi-Mailers	52.1	45.1	52.0	44.0	61.5	58.7	55.0	48.9
Catalogs	89.4	86.6	90.2	85.7	89.9	88.4	84.6	75.3
Multi-logs	51.6	55.1	51.5	56.3	50.3	45.8	53.2	42.9

A.5 Customer Service Detail

The Customer Service Detail file contains one record for every time the customer has contacted that department. The information includes the customer account number, the date, the method of contact (letter or phone call), and a reason code. There are approximately forty reason codes.

(This information is currently being extracted by the company and will be transmitted as soon as possible.)

A.6 Dependent Variable Construction

A.6.1 Discrete/Continuous Model

The chapter on discrete/continuous model presents both a three-choice model and a nested model. Both employ the choices of being frequently purchasers, occasional purchasers, and not purchasing. The dependent variable in the discrete choice equation is given by:

$$\begin{aligned} Choice \;=\; & (If\ Order\ Count \geq 2) \cdot 3 + \\ & (If\ Order\ Count = 1) \cdot 2 + \\ & (If\ Order\ Count = 0) \cdot 1. \end{aligned}$$

To compute the dependent variable for the continuous equation, the product price for each order detail line is aggregated to a dollars per marketing order. Then the dollars for each marketing order in the quarter are aggregated to total dollars per

customer. Refer to Tables A.4 and A.5 for summary statistics related to the dependent variables for a sample quarter, December 1993.

Table A.4: Discrete Choice – Frequency of Choices for December 1993

MODEL	CHOICE	NUMBER OF CASES	PERCENT
Dichotomous	Purchase	8145	20.9
	Do Not Purchase	30855	79.1
Three Choice	Purchase Multiple Times	2909	7.5
	Purchase Once	5236	13.4
	Do Not Purchase	30855	79.1

Data source is the quarter beginning December, 1993.

Table A.5: Continuous – Mean Dollar Amounts by Choice for December 1993

MODEL	CHOICE	AVERAGE DOLLARS
Dichotomous	Purchase	$198.87
Three Choice	Purchase Multiple Times	$329.88
	Purchase Once	$126.09

Data source is the quarter beginning December, 1993.

A.6.2 Time Independent Duration Model

The three states in the duration model are exiting on an order, exiting on becoming non-promotable, and the continuation state. In a given period, an individual who has not previously exited and does not place an order and does not become non-promotable, continues to the next period. If the "last" period is reached without exiting, the individual is considered "censored." Although the exact time of their next purchase is not known, or even if it occurs, it is known that they did not purchase for at least t periods. The majority of individuals exiting the model in the early periods exit by placing a subsequent order. However, the relatively large number of individuals becoming non-promotable within six months (two quarters) after placing an order should be noted. In addition, the proportion of individuals who never exit exceeds those who order again after five quarters. Refer to Table A.6 for the exit reasons by period.

Table A.6: Duration Model – Exit States by Period

	ORDER	NOT PROMOTABLE	NO EXIT
Period 1	6264	0	302
Period 2	4284	947	391
Period 3	1741	26	339
Period 4	956	21	293
Period 5	659	22	336
Period 6	367	14	509
Period 7	145	7	384
Period 8	59	3	409

It is necessary to establish a protocol for selecting the transition to study. This analysis employs the "most recent passage," where the passage selected begins with an individual placing an order.[7] In addition, we require than an individual is on the database for the duration of the passage. This restriction primarily applies to inactive consumers who are re-activated following a significant period during which they did not receive promotions. There is an additional complicating aspect of the discrete time intervals. An individual can simultaneously order and become non-promotable in a single period. To resolve this "aliasing" effect the protocol must prioritize the events. We have given ordering precedence over non-promotable, for the purposes of determining the exit period. However, this is reversed for the determination of the entry period. Given these requirements a discrete time/discrete choice model for estimating inter-purchase times can be built. Table A.6 gives the distribution of exit states by period as identified by this protocol.

A complication of the protocol which selects the "most recent passage" is that a decision must be made on selecting the consumers employed in the analysis. One option is to choose those individuals who place one or more orders in a specific time period and analyze their purchase patterns. The time periods selected should be sufficiently long that a second event, either another purchase or becoming non-promotable, occurs for a large number of individuals. A second option is to select the most recent passage for all consumers where such a passage can be found, regardless of the timing of the initial order which began the passage. We have selected this

[7]Note that the requirement to begin a passage on an order may be generalized.

option for the analysis. An advantage of this option is that it allows us to analyze the effect of absolute time, i.e., macro-economic trends and trends in consumer behavior. in addition to analyzing individual level behavior.

The process for determining the value of an individual's dependent variable, i.e., the length of time between orders, begins with evaluating their purchase history. If an individual has places two or more orders, then the passage to be considered is the time between the second-to-last order and the last order. If an individual has only placed one order, then the passage selected begins with that order, and ends at the end of "time," with the individual being considered a "censored" observation. The process becomes considerably more complicated if the individual has either become non-promotable, or has gone from a period of non-promotable to promotable. In this analysis we consider those cases where an individual orders, and at a later date become non-promotable. Because the process of moving from non-promotable back to promotable is extremely complicated, those individuals are not included in our analysis. The value of the dependent variable is then given by $Y_i = t_{exit} - t_{enter} + 1$. The censored variable is set to the exit reason codes given above.

To illustrate this process several examples are given below. Let C_{it} represent the order count for consumer i in period t. Let S_{it} represent the status of consumer i in period t, where $1 \equiv$ Promotable and $0 \equiv$ Non-promotable. Let Q_{it} be an indicator representing whether consumer i is on the current customer database in period t. The protocol requires that a consumer is "processed" from the most recent period backwards. The first occurrence of either an order or becoming non-promotable is

considered a potential exit. If in the backward search a second event is found, then the process is complete. If a second event is not found, then if the first occurrence is an order, it becomes the entry point and the consumer is considered "censored." For example, in Figure A.1, Customer 1 placed three orders in period 4, is a promotable customer, and exists on the customer database. In this case she is considered to have "entered" and "exited" the model in period 4. Both the enter and exit columns have been filled in appropriately, and the censored variable set to 1 (recall that 1 is exit on order). The dependent variable, denoted LHS, is set to 1.

Figure A.1: Duration Model – Dependent Variable Construction

	Period 1 $C_1S_1Q_1$	Period 2 $C_2S_2Q_2$	Period 3 $C_3S_3Q_3$	Period 4 $C_4S_4Q_4$	Dependent Variable Enter	Exit	Censor	LHS
Customer 1	211	011	111	311	4	4	1	1
Customer 2	211	011	111	011	1	3	1	3
Customer 3	011	111	011	011	2	4	0	3
Customer 4	011	011	011	111	4	4	0	1
Customer 5	011	511	011	011	2	2	1	1
Customer 6	011	111	001	011	2	3	2	2
Customer 7	111	111	111	111	7	8	1	2
Customer 8	011	111	011	001	2	4	2	3

A more complicated example is Customer 3. Note that this customer is considered a promotable customer and exists on the database in all periods. Proceeding backwards from period 4, the first order is found in period 2. At this point this order is a potential exit reason. Going back to period 1, no additional orders are found. Therefore, the order in period 2 becomes the entry reason, and the customer is considered "censored". In yet another example, Customer 6 exits in period 3 for becoming non-promotable, and enters in period 2 with an order. The remaining customers in Figure A.1 are provided as further illustration of the process.

A.7 Independent Variables

Table A.7 provides a definition for each independent variable employed in the analysis. Descriptive statistics (the mean, minimum, and maximum values) for the independent variables used in the discrete/continuous analysis are given in Table A.8. Table A.9 shows the means of the independent variables used in the duration model, by period. Table A.10 gives the values for the Model Age and Model Income brackets.

Table A.7: Independent Variables

VARIABLE	DEFINITION
New Customer	Profile Time As Customer Less Than One Year
Old Customer	Profile Time As Customer Greater Than Three Years
Spring	Months of March, April, and May
Fall	Months of September, October, and November
Winter	Months of December, January, and February
Beginning Quarter	Month of Entry to the Model - Captures Level Effects
Trend	Relative Month in Model - Captures Relative Effects
Open Balance	ARCG Remaining Receivable Balance (in 000's)
Percent Paid	ARCG Percent Paid for all Orders on Active A/R
Declining Balance	Credit History 90 Day Declining Balance Counter
No. of Solos	Number of Back-end Solos - Promotion Detail
No. of 8 Prods	Number of Back-end 8 Prods - Promotion Detail
No. of Catalogs	Number of Back-end Catalogs - Promotion Detail
Telephone	Profile Indicator for Presence of a Telephone
Rural Route	Profile Indicator for Rural Route Address
Apartment	Profile Indicator for Residing in Apartment
Model Age	Six Age Brackets
Model Marital Status	Married is "1", Otherwise "0"
Model Children	Indicator for Presence of Children
Model Income	Five Income Brackets
Model Dwelling Type	Multiple is "0", Single is "1"
Model Housing Tenure	Rent is "0", Own is "1"
African-American	% of Population Reporting African-American - 90 Census
Latino-American	% of Population Answering Affirmative to Hispanic Origin - 90 Census
Over 65/Live Alone	% of Households with Person 65+ Living Alone - 90 Census
Single Female Household	% of Households Headed by a Single Female -90 Census

Table A.8: Discrete/Continuous Model Independent Variables

VARIABLE	MEAN	MINIMUM	MAXIMUM
New Customer	0.31	0	1
Old Customer	0.50	0	1
Open Balance This Qtr	152.94	0.00	7,990.32
Open Balance Last Qtr	110.79	0.00	3,723.65
Percent Paid	30.85	0.00	100.00
Declining Balance	0.48	0	3
No. of Solos This Qtr	1.20	0	12
No. of Solos Last Qtr	1.49	0	18
No. of 8 Prods This Qtr	0.72	0	7
No. of 8 Prods Last Qtr	1.03	0	9
No. of Catalogs This Qtr	4.51	0	22
No. of Catalogs Last Qtr	7.93	0	34
Telephone	0.942	0	1
Rural Route	0.083	0	1
Apartment	0.069	0	1
Model Age	3.22	1	6
Model Marital Status	0.64	0	1
Model Children	0.54	0	1
Model Income	2.41	1	5
Model Dwelling Type	0.80	0	1
Model Housing Tenure	0.72	0	1
African-American	15.44	0	99
Latino-American	9.09	0	99
Over 65/Live Alone	9.41	0	99
Single Female Household	19.54	0	99

Table A.9: Duration Model – Independent Variable Means by Period

	PERIOD							
VARIABLE	1	2	3	4	5	6	7	8
New Customer	0.17	0.13	0.04	0.01	0.00	0.00	0.00	0.00
Old Customer	0.59	0.62	0.70	0.75	0.77	0.80	0.81	0.85
Spring	0.17	0.11	0.22	0.19	0.25	0.00	0.00	0.00
Fall	0.36	0.27	0.32	0.19	0.33	0.30	0.56	0.00
Winter	0.26	0.39	0.29	0.34	0.18	0.36	0.44	1.00
Beginning Quarter	5.45	4.66	3.57	2.94	2.45	2.02	1.44	1.00
Open Balance (in $)	215.73	260.12	145.64	95.18	60.72	37.62	22.02	12.03
Percent Paid	43.39	40.92	52.66	46.3	43.47	38.42	28.88	17.54
Declining Balance	0.75	0.62	0.92	0.80	0.62	0.45	0.28	0.17
No. of Solos	2.23	1.93	1.46	1.01	1.03	0.75	0.94	1.13
No. of 8 Prods	1.80	1.55	1.23	0.96	0.87	0.87	0.62	0.39
No. of Catalogs	10.22	8.78	8.49	7.71	8.92	7.88	7.73	4.41
Telephone	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99
Rural Route	0.09	0.09	0.10	0.10	0.10	0.10	0.09	0.08
Apartment	0.08	0.07	0.07	0.06	0.06	0.07	0.07	0.07
Model Age	3.43	3.48	3.62	3.67	3.71	3.76	3.76	3.87
Model Marital Status	0.61	0.62	0.67	0.68	0.68	0.69	0.69	0.69
Model Children	0.52	0.51	0.47	0.45	0.44	0.42	0.43	0.39
Model Income	2.35	2.32	2.48	2.61	2.70	2.80	2.87	2.93
Model Dwelling Type	0.79	0.80	0.82	0.83	0.83	0.83	0.82	0.81
Model Housing Tenure	0.68	0.69	0.75	0.78	0.78	0.79	0.79	0.82
African-American	15.52	14.85	13.85	13.76	13.20	13.32	13.83	13.74
Latino-American	9.34	9.27	8.99	8.74	8.40	8.22	8.68	8.27
Over 65/Live Alone	9.57	9.57	9.62	9.58	9.51	9.45	9.39	9.52
Single Female Household	19.58	19.47	19.40	19.28	19.20	19.24	19.30	19.29

Table A.10: Model Age and Model Income Brackets

VARIABLE		
Model Age	1	less than 25 years old
	2	25 years old to less than 35 years old
	3	35 years old to less than 45 years old
	4	45 years old to less than 55 years old
	5	55 years old to less than 65 years old
	6	65 years old and older
Model Income	1	up to $10,000
	2	over $10,000 to $20,000
	3	over $20,000 to $30,000
	4	over $30,000 to $40,000
	5	over $40,000

A.8 Duration Model Quarters

Based on the entry quarter and LHS for the duration model, the independent variables for an individual must be "shifted." Refer to Figures A.2 and A.3 for a diagram of this shifting. In Figure A.2 the independent variables are aligned with physical quarters. However, in order to estimate the model, logical quarters must be constructed. Therefore, the "enter" period becomes the first logical period, and all subsequent physical quarters are also shifted. Refer to Figure A.3 for the resulting data structure.

Figure A.2: Duration Model - Physical Quarters

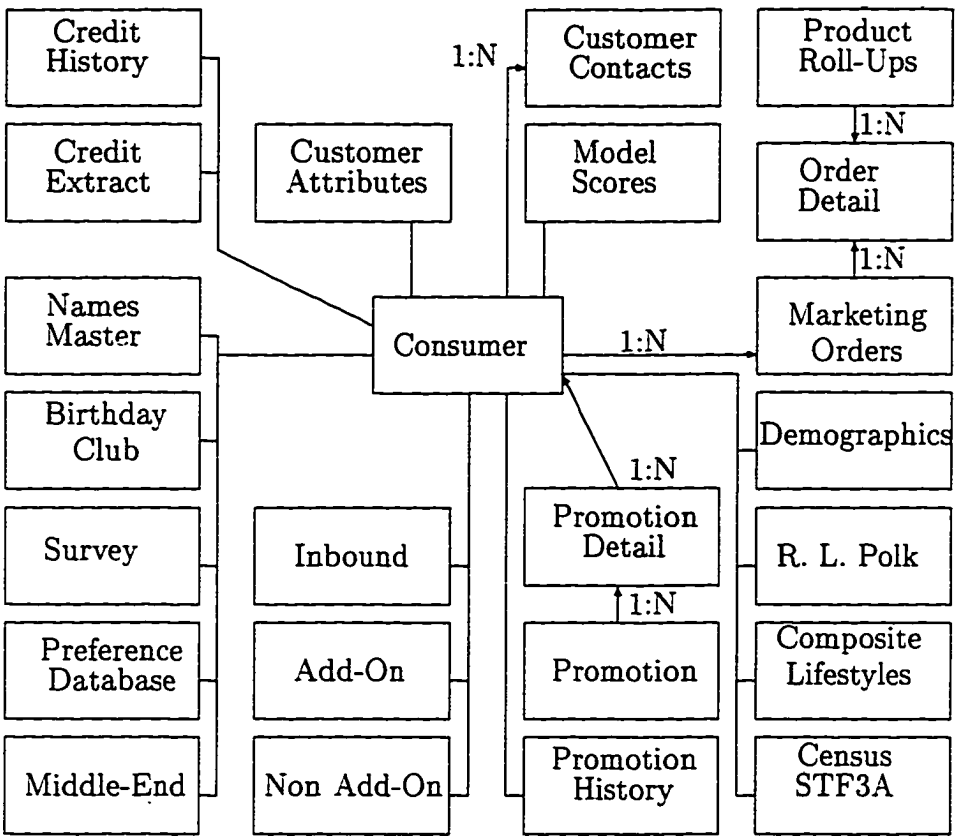
	Enter	Exit	Censor	LHS	M92	J92	S92	D92	M92	J93	S93	D93
Customer 1	1	4	1	4	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}
Customer 2	6	7	2	2	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_{27}	X_{28}
Customer 3	2	8	1	7	X_{31}	X_{32}	X_{33}	X_{34}	X_{35}	X_{36}	X_{37}	X_{38}
Customer 4	4	8	0	5	X_{41}	X_{42}	X_{43}	X_{44}	X_{45}	X_{46}	X_{47}	X_{48}
Customer 5	8	8	1	1	X_{51}	X_{52}	X_{53}	X_{54}	X_{55}	X_{56}	X_{57}	X_{58}

Figure A.3: Duration Model - Logical Quarters

	Enter	Exit	Censor	LHS	1	2	3	4	5	6	7	8
Customer 1	1	4	1	4	X_{11}	X_{12}	X_{13}	X_{14}				
Customer 2	6	7	2	2	X_{26}	X_{27}						
Customer 3	2	8	1	7	X_{32}	X_{33}	X_{34}	X_{35}	X_{36}	X_{37}	X_{38}	
Customer 4	4	8	0	5	X_{44}	X_{45}	X_{46}	X_{47}	X_{48}			
Customer 5	8	8	1	1	X_{58}							

A.9 Data Overview

Figure A.4: Entity Relationship Diagram



Appendix B Future Research with Additional Data

Future work employing this dataset, and additional pieces collected since this analysis was completed, include both technical and substantive efforts. In the area of technical analysis one step maximum likelihood functions could be derived for the durat/continuous models. In addition, the applicability of ordered probits should be investigated. There are also several generalizations related to the restrictions on the correlation between periods and between the discrete choice and the continuous amount that could be researched. It would also be appropriate to study various measures of goodness of fit using this particular dataset. Not only is it important to find models that predict reasonably well, but it is also important to know when to replace models in the direct marketing business.

On the substantive issues related to direct marketing and marketing in general, this company could be used as a basis for studying the elasticity of purchase decisions. Current research has primarily focused on a limited set of grocery products and a few durables. The effect of advertising on price sensitivity, as reported by Krishnamurthi and Raj [33], should also be investigated. There are several price plans available in different promotions, each with different numbers of payments for the same item. Kamakura and Russell's [27] probabilistic choice model for determining market seg-

ments and their elasticity structures is another area for further research. Perhaps different catalogs could be published for different segments, or different promotion policies (i.e., frequency) could be established for each segment. Given a combination of future research on segmentation and what is already known, hypothetical mailing policies should be investigated. Predicted response rates under different policies could then be compared to their actual response rates, assuming that the company would be willing to test the policies.

Since the cost data for each promotion is not available, any further analysis is required to assume constant cost. If a breakdown of the cost structure were available by component (e.g., paper, printing, packaging, postage, etc.), then the effect of adding additional pages or that of using heavier paper or better quality printing could be addressed.

This dataset is unique in that its set of customers is probably as close to being liquidity constrained as any group of customers. The process of becoming "non-promotable" and working oneself back to promotable by paying off late payments is interesting in itself. However, what may be of more interest is the estimation of a customer's lifetime value given that they may cycle through bad debt several times during their life.

In addition to the above mentioned areas of research, this analysis has left both an in-sample and out-of-sample set of purchase data unused. The models developed for the nine quarter period could be applied to the same customers for an additional four quarters, and also to additional customers in the nine quarters.

Additional areas of future research for which data is available are outlined below. They include customer contact, pricing and cost issues, determining promotion schedules, order details such as which products are ordered together, and cohort analysis.

B.1 Customer Contacts

From March of 1992 through June of 1995 the 50,000 customer in the dataset contact the company a total of 77,795 times for reasons other than placing an order. The available information includes their account number, the date, contact reason code, and contact source codes. Possible values for the later two are given in tables below. In addition to simply analyzing the frequency and nature of the calls, Schibrowsky and Lapidus [54] report guidelines for aggregating and analyzing complaints. Combined with the order information the customer contact information may also provide valuable insights into the frequency and pattern of purchases.

B.2 Pricing

There are several interesting aspects of pricing in direct marketing that are of interest. First, Kashyap [28] reported on price changes and found support for the concept of sticky prices in catalogs. Second, Mulhern and Leone [45] studied a multi-product approach to maximizing a store's profit. This could be related to the merchandising of "kits" and to the practice of dividing a general merchandise catalog into several

Table B.1: Contact Reason Codes

CODE	REASON	CODE	REASON
2	Keying Error	55	Statement Request
3	Keying Error	56	Extension Request
7	Keying Error	57	Credit / Collections
9	Keying Error	58	Return / Not Satisfied
14	Keying Error	59	Return / Instructions
30	Extension Request	60	Return / Miscellaneous
31	Coupon Request	61	Keying Error
32	Request Statement	77	Keying Error
33	What's my balance?	81	Product Warranty
34	Send Payment / Balance Dispute	82	Item Order Taken
36	Finance Charge	83	Hang-up or Disconnect
37	Shipping and Handling	84	Prank
38	Tax	85	Item Referred to Customer Service
39	Payment / Miscellaneous	88	Discount Coupon Handling
40	Backorder	89	Keying Error
43	MNR Shipped	90	Catalog Request
44	MNR Unshipped	91	Marketing / Miscellaneous
45	Delivery / Miscellaneous	92	Price Cut
46	Phone Order / MS40	93	Security Protection Plan
47	Unordered Merchandise	94	Financial Services
48	Order / Miscellaneous	95	COA / CON / Telephone #
49	Insurance Questions	97	IVR Order
50	Missing Parts	98	Keying Error
51	Free Gift	99	Miscellaneous / Other
52	Quality / Value		
53	Defective		
54	Wrong Size or Color		

Table B.2: Contact Source Codes

CODE	SOURCE
C	Correspondence
D	Phone (old)
F	Interface
I	Image
K	Data Entry
P	Phone

smaller, specialized catalogs. The process of determining which products to sell as a bundle with other products is central to this decision.

Krishna [32] reports on the effects of deal knowledge on consumer purchase behavior. In terms of this company, applying Krishna's model to the analysis of end-of-season electronics purchases may yield some new information on price elasticities when promotions are known.

The data available for this analysis includes the products ordered by the 50,000 customers, over a thirteen quarter period. For that time frame we also have the standard cost and the selling prices by start and end date pairs. For simplification this data could be aggregated to the product family.

B.3 Promotion Detail – Additional Information

Since many companies simply adjust their current year promotion schedule from that of last year, dropping unsuccessful promotions and adding new tests and creatives, it might be interesting to examine the sequence of promotions sent out by the company. The mail dates and quantities of each promotion for the time period under study is available.

B.4 Order Detail – Additional Information

The order line level detail is available for this dataset. Every item ordered, and the free gifts, along with their prices, order dates, and ship dates are available. Although

this data has been summarized for the purposes of the current analysis, future analysis could utilize the additional detail. Marketers have studied retail assortments (Betancourt [4] [5]), purchasing across categories (Blattberg [6]), perceived savings when purchasing bundled products (Yadav and Monroe [62]) and inter-product demand (Duffy [13]). All of these concepts could be studied using this company's data.

B.5 Cohort Analysis

Schmittlein, Morrison and Colombo [55] studied a financial institution and how they counted their active customers. Many consumer demand studies and the vast majority of direct marketing studies employ cross-sections rather than time series data. Because this data is available for a relatively long period of time, an analysis of customer attrition would be appropriate. Cohorts who became back-end customers at the same time could be analyzed for the length of time they remain customers and compared to other cohorts.

Appendix C Proof of Proposition 2

Dubin and McFadden [11] show that for conditional expectations of independent extreme value errors,

$$\mathrm{E}(\eta_{itk}|\delta_j(\bar{\epsilon})=1)=\begin{cases} -\log P_{itj} & \text{if } j=k \\ (P_{itk}(1-P_{itk})^{-1})\cdot\log P_{itk}\cdot\lambda & \text{if } j\neq k \end{cases}$$

where $\delta_j(\bar{\epsilon})$ is an indicator for choice j and $P_{itj}=\mathrm{Prob}[\delta_j(\bar{\epsilon})=1]$. Making the appropriate substitutions we obtain:[1]:

$$\begin{aligned} \mathrm{E}(\epsilon_{i0}|B_t) &= \mathrm{E}(\epsilon_{i0}|\delta_0(\bar{\epsilon})=1)=-\log\mathrm{Prob}B_t\cdot\lambda \\ \mathrm{E}(\epsilon_{i0}|B_{t-1}) &= \mathrm{E}(\epsilon_{i0}|\delta_0(\bar{\epsilon})=1)=-\log\mathrm{Prob}B_{t-1}\cdot\lambda \\ \mathrm{E}(\epsilon_{it1}|B_t) &= \mathrm{E}(\epsilon_{it1}|\delta_1(\bar{\epsilon})=1). \end{aligned} \tag{C.1}$$

For the case of $\mathrm{E}(\eta_{it}|B_{t-1})$ we note that ϵ_{itk} is independent of $\tilde{\epsilon}_{i(t-1)k}$ so that the conditional expectation is zero. By substitution,

$$\begin{aligned} \mathrm{E}(\epsilon_{i0}|B_t) &= -\log Q_t\cdot\lambda \\ \mathrm{E}(\epsilon_{i0}|B_{t-1}) &= -\log Q_{t-1}\cdot\lambda \\ \mathrm{E}(\epsilon_{it1}|B_t) &= [R_t/(1-R_t)]\cdot\log R_t\cdot\lambda \\ \mathrm{E}(\epsilon_{it1}|B_{t-1}) &= 0 \end{aligned}$$

where $R_t=\mathrm{Prob}[U_0<U_t,U_1<U_t,\ldots,U_{t-1}<U_t]$.

[1]Refer to the Duration/Continuous Model – Theory Chapter for definitions of the random variables and events, including B_t and Q_t.

Thus, with further substitution, we obtain:

$$\begin{aligned}
\mathrm{E}(\eta_{it}|B_t) &= R(\mathrm{E}(\epsilon_{it}|B_t) - \mathrm{E}(\epsilon_{i0}|B_t)) \\
&= \lambda R \cdot ([R_t/(1-R_t)] \log R_t + \log Q_t) \\
\mathrm{E}(\eta_{it}|B_{t-1}) &= R(\mathrm{E}(\epsilon_{it}|B_{t-1}) - \mathrm{E}(\epsilon_{i0}|B_{t-1})) \\
&= \lambda R \cdot \log Q_{t-1}
\end{aligned}$$

In addition,

$$\begin{aligned}
\mathrm{E}(\eta_{it}|A_t) &= \frac{\lambda R \cdot \log Q_{t-1} - \lambda R \cdot ([R_t/(1-R_t)] \log R_t + \log Q_t)(1-P_{it1})}{P_{it1}} \\
&= \left(\frac{\log Q_{t-1} - (1-P_{it1})([R_t/(1-R_t)] \log R_t + \log Q_t)}{P_{it1}} \right) \cdot (\lambda R) \\
&= \left(\frac{Q_{t-1} \log Q_{t-1} - Q_t \log Q_t - Q_t [R_t/(1-R_t)] \log R_t}{Q_{t-1} - Q_t} \right) \cdot (\lambda R)
\end{aligned}$$

Q.E.D.

Bibliography

[1] Takeshi Amemiya. *Advanced Econometrics.* Harvard University Press, Cambridge, MA, 1985.

[2] Eugene W. Anderson. Cross-category variation in customer satisfaction and retention. *Marketing Letters*, 5(1):19–30, 1994.

[3] Robert Bednarzik. A special focus on employment growth in business services and retail trade. In Thierry Noyelle, editor, *Skills, Wages, and Productivity in the Service Sector.* Westview Press, Inc., Boulder, CO, 1990.

[4] Roger Betancourt and David Gautschi. Demand Complementarities, Household Production and Retail Assortments. *Marketing Science*, 9:146–161, 1990.

[5] Roger R. Betancourt and David Gautschi. The demand for retail products and the household production model: New views on complementarity and substitutability. *Journal of Economic Behavior and Organization*, 17:257–275, 1992.

[6] Robert C. Blattberg, Peter Peacock, and Subrata K. Sen. Purchasing strategies across product categories. *Journal of Consumer Research*, 3:143–154, 1976.

[7] Harvey D. Braun. The catalog shopper of the 90's. *Direct Marketing*, 55(11):15–18, 1993.

[8] Tom J. Brown and Michael L. Rothschild. Reassessing the impact of television advertising clutter. *Journal of Consumer Research*, 20:138–146, 1993.

[9] Rita Cain. The taxing problem surrounding mail-order sales. *Taxes*, pages 398–402, 1990.

[10] David L. Cohen. *The Good Old Days*. Simon and Schuster, New York, NY, 1940.

[11] Jeffrey A. Dubin and Daniel McFadden. An econometric analysis of residential electric appliance holdings and consumption. *Econometrica*, 52(2):345–362, 1984.

[12] Jeffrey A. Dubin and Douglas Rivers. Experimental estimates of the impact of wage subsidies. *Journal of Econometrics*, 56:219–242, 1993.

[13] Martyn H. Duffy. Advertising and the inter-product distribution of demand. *European Economic Review*, 31:1051–1070, 1987.

[14] A. S. C. Ehrenberg. The pattern of consumer purchases. *Applied Statistics*, 8:26–41, 1959.

[15] Scott Fischer and C. Randall Byers. Using systems technology to improve inventory management in a mail order business. *Journal of Systems Management*, pages 24–28, 1992.

[16] Denise Gellene. Less mail on order: Paper and postage hikes are trimming catalogue industry. Los Angeles Times, 1995. September 17, 1995.

[17] Timothy H. Gillis. Collecting the use tax on mail-order sales. *Georgetown Law Review*, 79:535–565, 1991.

[18] Mary C. Gilly and Betsy D. Gelb. Post-purchase consumer processes and the complaining consumer. *Journal of Consumer Research*, 9:323–328, 1982.

[19] Sunil Gupta. Stochastic models of interpurchase time with time-dependent covariates. *Journal of Marketing Research*, 28:1–15, 1991.

[20] Sunil Gupta and Donald G. Morrison. Estimating heterogeneity in consumer purchase rates. *Marketing Science*, 10(3):264–269, 1991.

[21] Behram J. Hansotia. Can you predict when your customers will leave? *Direct Marketing*, 55(11):24–26, 1993.

[22] James J. Heckman. Statistical models for discrete panel data. In Charles F. Manski and Daniel McFadden, editors, *Structural Analysis of Discrete Data with Econometric Applications*. MIT Press, Cambridge, MA, 1981.

[23] Kristiaan Helsen and David C. Schmittlein. Analyzing duration times in marketing: Evidence for the effectiveness of hazard rate models. *Marketing Science*, 12(4):395–414, 1993.

[24] C. Hildreth and J. P. Houck. Some estimates for a linear model with random coefficients. *Journal of the American Statistical Association*, 63:584–595, 1968.

[25] Dipak Jain and Naufel J. Vilcassim. Investigating household purchase timing decisions: A conditional hazard function approach. *Marketing Science*, 10(1):1–23, 1991.

[26] Rose L. Johnson and Cathy J. Cobb-Walgren. Aging and the problem of television clutter. *Journal of Advertising Research*, 34(4):54–62, 1994.

[27] Wagner A. Kamakura and Gary J. Russell. A probabilistic choice model for market segmentation and elasticity structure. *Journal of Marketing Research*. 26:379–390, 1989.

[28] Anil K. Kashyap. Sticky prices: New evidence from retail catalogs. *Quarterly Journal of Economics*, 110(1):254–274, 1995.

[29] D. Roderick Kiewiet. *Macroeconomics & Micropolitics*. University of Chicago Press, Chicago, IL, 1983.

[30] Philip Kotler. *Marketing Management: Analysis, Planning, Implementation, and Control*. Prentice Hall, Englewood Cliffs, New Jersey, 6th edition, 1988.

[31] Philip Kotler. *Marketing Management: Analysis, Planning, Implementation, and Control*. Prentice Hall, Englewood Cliffs, New Jersey, 9th edition, 1997.

[32] Aradhna Krishna. The effect of deal knowledge on consumer purchase behavior. *Journal of Marketing Research*, 31:76–91, 1994.

[33] Lakshman Krishnamurthi and S. P. Raj. The effect of advertising on consumer price sensitivity. *Journal of Marketing Research*, 22(2):119–129, 1985.

[34] Laura A. Kulwicki. The validity of state use taxes on the distribution of catalogs and other promotional materials. *State Tax Notes*, pages 641–646, 1994.

[35] Frank Latham. *1872–1972 A Century of Serving Consumers.* Montgomery Ward & Co., Incorporated, Chicago, IL, 1972.

[36] Edmund O. Lawler. Direct mail: Customer-retention features frequently get overlooked. *Business Marketing*, 79:20–21, 1994.

[37] William Leach. *Land of Desire.* Pantheon Books, New York, NY, 1993.

[38] Stanley Marcus. *Minding the Store.* Little, Brown and Company, Boston, MA, 1974.

[39] Daniel McFadden. Conditional logit analysis of qualitative choice behavior. In P. Zarembka, editor, *Frontiers in Econometrics.* Academic Press, Inc., New York, NY, 1973.

[40] Daniel McFadden. Modelling the choice of residential location. In A. Karlquist et. al., editor, *Spatial Interaction Theory and Residential Location*, pages 75–96. North-Holland Publishing Company, Amsterdam, 1978.

[41] Steven C. Michael. Competition in organizational form: Mail order versus retail stores, 1910-40. *Journal of Economic Behavior and Organization*, 23:269–286, 1994.

[42] George R. Milne and Mary Ellen Gordon. A segmentation study of consumers' attitudes toward direct mail. *Journal of Direct Marketing*, 8(2):45–52, 1994.

[43] Donald G. Morrison and David C. Schmittlein. Predicting future random events based on past performance. *Management Science*, 27:1006–1023, 1981.

[44] Donald G. Morrison and David C. Schmittlein. Generalizing the nbd model for customer purchases: What are the implications and is it worth the effort? *Journal of Business and Economic Statistics*, 6:145–166, 1988.

[45] Francis J. Mulhern and Robert P. Leone. Implicit price bundling of retail products: A multiproduct approach to maximizing store profitability. *Journal of Marketing*, 55:63–76, 1991.

[46] Thierry Noyelle. *Skills, Wages, and Productivity in the Service Sector.* Westview Press, Inc., Boulder, CO, 1990.

[47] B. Peter Pashigian and Brian Bowen. The Rising Cost of Time of Females, the Growth of National Brands, and the Supply of Retail Services. *Economic Inquiry*, 32:33–65, 1994.

[48] Beatrice Plumb. *J. C. Penney, Merchant Prince.* T. S. Denison & Company, Inc. , Minneapolis, MN, 1963.

[49] S. P. Raj. The effects of advertising on high and low loyalty consumer segments. *Journal of Consumer Research*, 9:77–89, 1982.

[50] Vithala R. Rao and Joel H. Steckel. Selecting, Evaluating, and Updating Prospects in Direct Mail Marketing. Technical Working Paper 94–121, Marketing Science Institute, 1994.

[51] Murray Raphel. The art of direct marketing: Upgrading prospects to advocates. *Direct Marketing*, 58(2):34–37, 1995.

[52] Arthur R. Rosen. More on mail-order sales taxation. *Taxes*, pages 755–760, 1990.

[53] Peter E. Rossi, Robert E. McCulloch, and Greg M. Allenby. Is household-specific targeting worth it? Report 94–118, Marketing Science Institute, 1994.

[54] John A. Schibrowsky and Richard S. Lapidus. Guidelines for direct marketers to aggregate and analyze third-party complaints. *Journal of Direct Marketing*, 8(4):40–50, 1994.

[55] David D. Schmittlein, Donald G. Morrison, and Richard Colombo. Counting your customers: Who are they and what will they do next? *Management Science*, 33:1–24, 1987.

[56] Itamar Simonson. The effect of purchase quantity and timing on variety-seeking behavior. *Journal of Marketing Research*, 27:150–162, 1990.

[57] Orange A. Smalley and Frederick D. Sturdivant. *The Credit Merchants: A History of Spiegel, Inc.* Southern Illinois University Press, Carbondale, IL, 1973.

[58] Keith Snavely. State taxation of interstate sales: Enforcement problems and prospects. *Public Budgeting and Finance*, 10:60–71, 1990.

[59] Thomas M. Stanback Jr. The changing face of retailing. In Thierry Noyelle, editor, *Skills, Wages, and Productivity in the Service Sector*. Westview Press, Inc., Boulder, CO, 1990.

[60] Jennifer Steinhauer. Kmart to test its own label credit card. The New York Times, 1996. March 11, 1996, Section C.

[61] Glenn T. Sueyoshi. A class of binary response models for grouped duration data. *Journal of Applied Econometrics*, 1994. forthcoming.

[62] Manjit S.Yadav and Kent B. Monroe. How buyers perceive savings in a bundle price: An examination of a bundle's transaction value. *Journal of Marketing Research*, 30:350–358, 1993.

[63] Naufel J. Vilcassim and Dipak C. Jain. Modeling purchase-timing and brand-switching behavior incorporating explanatory variables and unobserved heterogeneity. *Journal of Marketing Research*, 28:29–41, 1991.

[64] Paul Wang and Ted Splegel. Database marketing and its measurements of success. *Journal of Direct Marketing*, 8(2):73–81, 1994.

[65] Rita D. Wheat and Donald G. Morrison. Assessing purchase timing models: Whether or not is preferable to when. *Marketing Science*, 9(2):162–170, 1990.

[66] Douglas Wolf and David Greenberg. The dynamics of welfare fraud: An econometric duration model in discrete time. *Journal of Human Resources*, 21:437–455, 1987.