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# Department of Agricultural \& Resource Economics, UCB CUDARE Working Papers (University of California, Berkeley) 

# Effect of Sales on Brand Loyalty 

Rui Huang<br>University of California, Berkeley<br>Jeffrey M. Perloff<br>University of California, Berkeley<br>Sofia B. Villas-Boas<br>University of California, Berkeley

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#### Abstract

Although many theoretical industrial organization models are based on the existence of a critical mass of exogenously "brand loyal" consumers, we find little empirical evidence supporting these assumptions in the orange juice retail market. There are very few loyal consumers. More importantly, the frequency with which stores conduct sales affects the share of loyal types so that loyalty is endogenous rather than exogenous. Households' demographics have statistically significant but economically minor effects on switching behavior. Switching across frozen and refrigerated states is very common, leading to more complicated substitution patterns and less loyalty than one observes looking at each state separately.


# Effect of Sales on Brand Loyalty ${ }^{\dagger}$ 

Rui Huang*<br>Jeffrey M. Perloff**<br>Sofia B. Villas-Boas***

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Although many theoretical industrial organization models are based on the existence of a critical mass of exogenously "brand loyal" consumers, we find little empirical evidence supporting these assumptions in the orange juice retail market. There are very few loyal consumers. More importantly, the frequency with which stores conduct sales affects the share of loyal types so that loyalty is endogenous rather than exogenous. Households' demographics have statistically significant but economically minor effects on switching behavior. Switching across frozen and refrigerated states is very common, leading to more complicated substitution patterns and less loyalty than one observes looking at each state separately. (Keywords: Loyalty; Sales)

\author{

* Graduate Student, Department of Agricultural \& Resource Economics, University of California, Berkeley <br> ** Professor, Department of Agricultural \& Resource Economics, University of California, Berkeley, and member of the Giannini Foundation <br> *** Assistant Professor, Department of Agricultural \& Resource Economics, University of California, Berkeley, and member of the Giannini Foundation
}

[^0]Most theoretical models of sales (e.g., Varian, 1980; Narasimhan, 1988; Lal, 1990) and theoretical and empirical work on firm’s strategic pricing and advertising behavior (e.g., Agrawal, 1996; Fishman, 1994) assume that a critical mass of consumers have an intrinsic loyalty to a brand, so that they buy only that brand over time. ${ }^{1}$ However, our empirical evidence of switching behavior by orange juice consumers shows that firms’ pricing behavior affects whether orange juice consumers switch and that few consumers are actually loyal to one brand. ${ }^{2}$ Moreover, we find that switching is more complex than generally assumed in these theoretical models: Consumers switch between two types of products: frozen and refrigerated orange juice.

Some theoretical models also require that firms be able to identify loyal customers, where an extensive marketing literature concentrates on identifying loyal customers (Jacoby and Chestnut, 1978; Grover and Srinivasan, 1987; Colombo and Morrison, 1989). Among the many explanations for brand loyalty, marketing researchers have identified customer inertia, decision biases, uncertainty in the quality of other brands, or other issues. As many of these characteristics cannot be observed, we try to predict switching behavior using only observable household demographic and store characteristics.

[^1]In our model, loyalty or switching behavior depends on consumer characteristics and the frequency with which stores conduct sales: temporary reductions in price from the usual or modal price. We examine switching behavior for the two best-selling types of orange juice products: refrigerated and frozen orange juice. ${ }^{3}$ We chose orange juice because we were interested in whether switching depended on the ability to store goods bought on sale, which is possible with frozen but not refrigerated juice.

We now turn to our empirical model. Next, we describe the data and define our variables. Then, we present summary statistics and our formal empirical results and briefly draw conclusions.

## THE EMPIRICAL MODEL

We investigate the relationship between switching behavior and consumer demographics using multinomial logit analyses. The classified response variable is the group membership of a household, where the groups reflect loyal or switching behavior.

We use cross-sectional, time series data on household purchases of orange juice from cities across the country. We use two main types of explanatory variables as well as city dummies. First, we include household characteristics. These characteristics include ages of female and male heads, income, household size, education and occupation of the heads, and presence of young kids. Wealthy families may ignore sales. Presumably, a lower-income, larger-size household is more prone to buy the least expensive product-switch when sales occur—and thus exhibit less loyalty to particular brands. Similarly, brand loyalty may differ with the age of children. Older children may prefer brands more strongly than younger ones or

[^2]parents who believe that certain brands of orange juice are more nutritious may be more inclined to buy a single brand for younger children. Some speculation in the press holds that educated families are more likely to buy generics—be less loyal—than other families.

Second, we use two variables to capture the frequency of sales at each store. One variable is the frequency of sales, while the other is a dummy that equals one if the store never has a sale (to capture nonlinear effects at zero). Presumably in the absence of sales, even nonloyal consumers have little incentive to switch between brands. It is this presumption that the theoretical literature implicitly rejects by assuming that loyalty is inherent or exogenous.

## DATA

We use Information Resources Incorporated’s (IRI) InfoScan® Household Paneldata for 1997 through 1999. IRI collects data on individual purchases from grocery stores and on prices directly from grocery stores' databases and in other ways. The store-level data set includes weekly prices, total sales quantities, promotion activities (price reduction, special display, retail ads, and any other type of promotion excluding coupons), and other information by product UPC (Universal Product Code).

The IRI customer database includes weekly purchases by individual households and annual (or time-invariant) demographic information for each household. This dataset has detailed information on the number of visits to grocery stores by a household, total units of products the household bought by UPC in each visit, and price per unit paid. We have annual demographic data for each household on annual household income, household size, age, employment status/occupation, and educational levels of the female and male heads of the
households. Our sample consists of 39,834 observations of purchases at weekly intervals by households in 24 cities. ${ }^{4}$

We construct three subsamples from our IRI datasets: refrigerated orange juice, frozen orange juice, and both types ("combined") of orange juice. In each sample, we assign households to one of a mutually exclusive and exhaustive set of groups based on their switching behavior. Our categories are similar but not identical across our three samples. For the frozen and refrigerated samples, the first group consists of loyal consumers who purchase a top-selling national brand; the second consists of those who are loyal to the store's private-label product; and the other two include people who switch between top national brands and private labels or who purchase other brands. ${ }^{5}$

The combined sample has customers who are loyal to a national brand, those who switch within a type, and those who switch between types. ${ }^{6}$ We experimented with an alternative categorization of the groups, which further divided the first groups into three subgroups. The first two subgroups are those loyal to Tropicana and Minute Maid and who never switches, and the third subgroup are those consumers who do not buy anything else than these two brands, but switch between the two. We did not find our results sensitive to this alternative way of

[^3]categorization. Therefore, we are presenting the simpler version as follows. The specific categories are:

## Refrigerated sample

1. Name brand loyal: Households that bought only one or both of the two leading brands, Tropicana and Minute Maid in a year.
2. Private label loyal: Households that always bought the private label in a year.
3. Switch between private label and top name brands: Households that bought the private label and at least one of the two leading brands, but no other brands in a year.
4. Others: Consumers who buy minor brands (who may or may not switch between them and name-brand or private label products).

## Frozen Sample ${ }^{7}$

1. Name brand loyal: Households that bought only the leading national brands (Minute Maid, Tropicana, Old Orchard Premium, Florida Golden, Sun Bright, and Sunkist) during a year.
2. Private label loyal: Households that bought only the private label during a year.
3. Switch between private label and top name brands: Households that switch between the private label and the top national brands during a year.

## 4. Others.

[^4]
## Combined Sample

1. Only frozen, name brand loyal: Households that bought exclusively the leading national brands of frozen orange juice.
2. Only frozen, bought non-name-brand products: Households that bought exclusively frozen orange juice and bought the private label, minor brands, or switched between leading national brands and other products during a year.
3. Only refrigerated, name brand loyal: Households that bought exclusively the top refrigerated national brands during a year.
4. Only refrigerated, bought non-name-brand products: Households that bought exclusively refrigerated orange juice and bought the private label, minor brands, or switched between leading national brands and other products during a year.
5. Switched between frozen and refrigerated: Households that switched between frozen and refrigerated orange juice during a year.

We observe a household's purchasing behavior over a year. For each of the subsamples, we excluded households that made fewer than two purchases in a year, because group memberships are indeterminate for such households as we cannot observe switching behavior. We dropped 10,285 household-years out of 65,529 household-year observations in the refrigerated dataset (16\%), 10,734 (30\%) out of 36,101 observations in the frozen dataset, and 9,864 household-years (13\%) were dropped from a total of 77,102 observations in the combined sample.

Our second step was to match the group indexed household level data with household demographics by household and by year. Because of an inability to properly assign demographic information to some households, we dropped 9,869 household-year observations (18\%) of the

55,244 observations in the refrigerated household level data, 4,017 (16\%) out of 25,367 in the frozen sample, and 11,933 (18\%) out of 67,238 in the combined data set. Our third step was to match store-specific information from the store-level data set to our household data.

We want to investigate how a household's tendency to switch between brands is conditional on the frequencies of sales in the stores that a household visits. To do so, we need to define a sale and decide how to treat households that shop at more than one grocery store. In most previous research, a sale is defined as occurring if the price is below a specified fraction of the modal (regular) price within a given period. Hendel and Nevo (2002) considered the fractions $5 \%, 10 \%, 25 \%$, or $50 \%$. We define a sale as occurring when the price is at least $25 \%$ below the modal price during a year; however our experiments show that our results are qualitatively robust to other choices of the threshold. We define a stores’ sales frequency during a year as the percentage of weeks that a product is on sale.

If a household shops at several stores during a year, we focus on the store that it visited the most times during the year. We define the sales frequency as the average fraction of weeks that the five best-selling orange juice UPCs are on sale (based on store-level data) for each type of orange juice. ${ }^{8}$ If the store does not carry each of the top five UPCs, the mean is computed from the subset that the store carries. If none of the five UPCs is available at a store for a year, then we set the sales frequency equal to zero. We also define a binary dummy for no sales for each state of orange juice that equals one if there are no sales for the five top-selling UPCs and zero otherwise.

[^5]We then match these measures to the group-indexed household demographics by store and by year. We have 45,330 observations in the refrigerated dataset, 21,345 in the frozen dataset, and 55,291 in the combined dataset. We had to drop 45 (0.1\%), 5 (0.2\%), and 44 (0.1\%) observations in these datasets respectively where we could not match properly because we could not determine the year to which the demographic characteristics applied. In addition, we kept only 12,359 household year observations in the frozen dataset when we drop the cities for which not all four groups are present.

## SUMMARY STATISTICS

We present the summary statistics in Table 1 for the three samples: refrigerated orange juice, frozen orange juice, and the combined sample. The summary statistics alone allow us to draw five results about loyalty.

Result 1: Switching behavior is extremely common and brand loyalty is relatively uncommon for orange juice. If we look at just one type of orange juice at a time, we find that 61 percent of the frozen orange juice customers and 77 percent of the refrigerated orange juice customers switch or buy minor brands (Groups 3 and 4). In the combined data set, all but 8 percent of the sample (Group $1+$ Group 3) switch within or between types of juice. Perhaps most striking is that 60 percent of all consumers switch between refrigerated and frozen orange juice products.

There is even more switching than our figures indicate for two reasons. First, some of the consumers whom we describe as loyal to leading national brands actually switch between these brands. Second, our analysis ascribes loyalty to a consumer who did not switch within a year; however, were we to change our horizon to two or three years, virtually no household is loyal.

Result 2: Roughly twice as many consumers of refrigerated or frozen juice are loyal to the leading national brands as to a private label. Of frozen orange juice consumers, 25 percent are loyal to a leading brand-name product (Group 1) and 14 percent to the private label (Group 2). ${ }^{9}$ In contrast for those who consume refrigerated orange juice, only 16 percent are loyal to the top brand name (Group 1) and only 6 percent to the private label (Group 2).

Result 3: The share of loyal customers varies substantially across types of orange juices. The share of loyal customers (Groups 1 and 2 ) is 39 percent for the frozen orange juice sample compared to only 22 percent for the refrigerated juice sample. However, in the combined sample (where switching between frozen and refrigerated products becomes possible), 3 percent are loyal to a name-brand frozen orange juice, and 5 percent are loyal to a refrigerated name-brand product.

Result 4: Frozen orange juice consumers are more likely to be loyal than are refrigerated juice consumers. The share of consumers who are loyal to a leading national brand is 18 percent for frozen juice and 8 percent for refrigerated. The corresponding figures for loyalty to a private label are 14 and 6 percent. Because it is easier to store frozen juice, there may be more of an incentive to respond to sales. However, the leading frozen brand dominates its category more than does the leading refrigerated brand. ${ }^{10}$ In addition, sales are also less common for frozen than refrigerated juice: One third of the stores never have sales of frozen juice, whereas only a quarter fails to put refrigerated juice on sale.

[^6]Result 5: Looking only within frozen or within refrigerated juices provides a misleading picture that there is more loyalty than when we take account of switching between types. We find substantially less national brand loyalty if we allow consumers to switch between frozen and refrigerated products than if we look at just one or the other type of juice: The share of consumers who buy only leading national brands drops from 25 percent to 3 percent for frozen and from 16 percent to 5 percent for refrigerated.

Table 1 also shows very small difference in the summary statistics for the explanatory variables across the samples. Moreover, there are only a couple patterns in the explanatory variables across the samples. Families with small children are slightly more likely to buy frozen orange juice or switch than to buy the more expensive refrigerated juice. Slightly more of families with incomes over $\$ 100,000$ buy refrigerated rather than frozen juice. ${ }^{11}$

## MULTINOMIAL LOGIT RESULTS

We can only infer a limited amount from summary statistics. We want to know how various consumer characteristics and stores' frequency of sale affect consumers’ switching behavior holding other factors constant. To do that, we use multinomial logit to estimate our full model for each of our three samples.

We believe that it is reasonable to assume that consumers view the sales frequency variables as exogenous. It seems unlikely that the frequency of sales of orange juice products alone substantially affects consumers' choice of which grocery store they are most likely to shop in over a year. The average probability that a consumer buys orange juice on sale is 17.2 percent

[^7]if the consumer shops at the store the consumer visits most frequently and 17.4 percent at other stores for the combined sample. ${ }^{12}$ We also lack appropriate instruments so as to deal with potential endogeneity directly.

One might also be concerned about endogeneity problems arising from stores’ reactions to consumers' choices. We regressed the frequency of sales in stores on the characteristics of its customers and found no correlation (indeed, no coefficient had a t-statistic as high as one). In short, we have no compelling evidence as to why the frequency of sales varies across stores and view these decisions as essentially exogenous for our purposes.

Consequently, for those readers who question the endogeneity of the sales frequency variable, we also estimated restricted (reduced-form) models, where we dropped the sales frequency variables and included only the consumer characteristics and city dummies.

The estimated multinomial logit results for both the full models and the restricted models and the associated outcome matrices are presented in Appendix 1. The individual dummy variables are listed there. The models fit reasonably well for large cross sections (the time series is relatively short), as shown by the outcome matrices. The pseudo- $\mathrm{R}^{2}$ measures for the full models are 0.076 for frozen orange juice, 0.108 for refrigerated juice, and 0.074 for the combined model. ${ }^{13}$

As the estimated coefficients themselves are of relatively little interest by themselves, we concentrate on hypothesis tests of the coefficients and simulation results based on the estimated models. In Table 2, we report a large number of hypothesis tests. We use imprecise terminology

[^8]and say that a result is "statistically significant" if we can reject the null hypothesis of no effect at the 0.05 level. The next to last row of the table shows that all six multinomial logit analyses are statistically significant (we can reject the null hypothesis that only the constant matters—all the slope coefficients are collectively zero).

The first row of Table 2 shows the likelihood-ratio test statistics against the hypothesis that all the coefficients for the sales frequency and the sales dummy are collectively zero. (In addition, each variable is statistically significant in all three full-models, though the table does not show those statistics.) That is, if one accepts that the sales frequency variables are exogenous, one can reject dropping these variables from the full model to obtain the restricted model.

Most of the demographic variables are also statistically significant in some or all models. All the variables related to income and wealth (own your own house), household size (number of members in the family), and the city dummies are statistically significant in all the analyses. The only set of variables that is never statistically significant is the set of dummies related to the male head of household's occupation. The other sets of demographic variables are statistically significant in some (usually half or more) but not all the analyses.

## SIMULATION RESULTS

We also want to know if variables have economic significance. Do changes in the explanatory variables have a substantial effect on the shares of the various loyalty groups? Because the multinomial logit is highly nonlinear, we cannot answer this question by inspecting the corresponding coefficients. One standard method of showing the impact of a variable is to report marginal effects using elasticities or partial derivatives. However, because most of our variables are discrete or have known ranges, we find that an equivalent simulation approach is
clearer. We use our estimated model to simulate the impact of changes in only one explanatory variable at a time on the probability that a typical household belongs to each group, where we hold the other explanatory variables fixed (continuous explanatory variables at the sample means and the discrete characteristics at the values taken by the majority of households in the sample).

The simulation results are reported in Tables 3, 4, and 5 for the refrigerated, frozen, and combined samples respectively. We report simulations for the statistically significant variables except the 24 city dummies.

Result 6: When the frequency of sales rises, fewer consumers of orange juice remain loyal to a national brand and switching behavior increases. Holding the other right-hand variables fixed, as we increase the percentage of weeks that the store visited most often by a household has sales within a year, the probabilities of remaining loyal to a national brand shrinks monotonically, and the probability of being a switcher rises. If a store were to increase its frequency of sales from $0 \%$ to $15 \%$ (the observed range), the probability of its refrigerated orange juice customers being loyal to a national brand (Group 1), falls from 8 percent to 2 percent, the probability of being loyal to a private label (Group 2) drops negligibly, so the share who are switchers (Groups 3 and 4) rises from 86 percent to 93 percent. ${ }^{14}$ The comparable figures for frozen juice consumers are: 20 percent to 4 percent, 12 percent to 6 percent, and 68 percent to 90 percent. For the combined sample, an increase in the frequency of both types of juice reduces the share of consumers who are loyal of a national brand or frozen or refrigerated juice, switching within a type of juice falls, but switching between types of juices rises substantially. If we set the sales frequency for refrigerated juice at 0.1 percent and increase the frequency of sales of frozen, we again see a decline in national brand loyalty. However, if we set

[^9]the frequency of sales for frozen at 0.1 percent and raise the frequency for refrigerated juice, strangely loyalty to both types of national brands rises. Thus, with one exception, as the frequency of sales increases, a household becomes less loyal to a national brand and more willing to switch.

Although demographic characteristics tend to affect switching behavior in the direction that we would have expected, changes in these characteristics have smaller effects than does a change in the frequency of sales. For some statistically significant variables, such as the female education dummies, the effects are negligible. In the following, we discuss a few of the larger effects.

Result 7: As household income rises, consumers are more likely to be loyal to a national brand, less likely to be loyal to a private label, and less likely to switch. In short, wealthy households buy a leading national brand and stick with it, even though it may cost more than other brands. As household income rises from \$30,000 to over \$100,000, the share of refrigerated juice consumers who are loyal to the national brand nearly doubles from 7 to 13 percent, while the share who buy frozen drops from 6 to 3 percent. The comparable figures for frozen juice consumers are 17 to 27 percent and 14 to 9 percent. As income rises, the share of the combined sample who are loyal consumers of the leading brands falls from 0.7 to 0.5 percent for frozen and from 0.9 to 0.3 percent for refrigerated.

Result 8: As household size increases, consumers are more likely to buy a private label. The reward to buying inexpensive brands rises with family size. This increase comes at the expense of leading national brands; however, the share of switchers remains relatively unchanged. As the household size rises from 2 to 5 people, the share that are loyal to the national brand falls from 8 to 6 percent and the share that buys the private label rises from 5 to 7
percent for the refrigerated sample. The comparable figures for the frozen sample are 20 to 14 percent and 13 to 16 percent.

Result 9: Renters are more likely to be loyal than are home-owners. Surprisingly, renters are slightly more likely to be loyal to both leading national brands and to a private label than are home-owners. Consequently, renters are less likely to be switchers.

Result 10: Race affects loyalty to a national brand for refrigerated orange juice. The race variables are not collective statistically significant for the frozen sample. For refrigerated juice, the probability that a white consumer is loyal to a leading national brand is 8 percent compared to 7 percent for Hispanic consumers, and 6 percent for black consumers. Race has negligible effects on loyalty to a private label.

Result 11: Senior citizens exhibit less brand loyalty for refrigerated orange juice than do younger consumers. Age variables are not statistically significant determinants of switching behavior in the frozen or combined samples. In the refrigerated sample, older consumers are less likely to be loyal to either a name brand juice or a private label. This result contrasts with pharmaceuticals, where older consumers were more likely than others to buy a name-brand instead of a generic drug. ${ }^{15}$ One possible explanation here is that older consumers are more likely to have sampled various brands and found them to be generally equivalent in taste than younger consumers.

By comparing the full-model and the restricted-model (in Appendix 2) simulations, we find that the magnitudes of the demographic effects for the full model are slightly smaller than

[^10]those of the restricted model, but the directions of these effects are generally the same. Consequently, all but the sales frequency results hold for the restricted model.

## CONCLUSIONS

We have studied how demographic characteristics and the frequency of sales affect consumers’ switching behavior. Our results are generally consistent with our expectations. However, these empirical results are not consistent with the assumptions commonly made in theoretical industrial organization models that there is a critical mass of exogenously brand-loyal consumers. Some theoretical models also require that a store be able to identify switchers, which our results suggest is difficult because, although many observable consumer characteristics are statistically significantly related to switching behavior, we find that changes in most consumer characteristics have relatively small effects on such behavior.

We find that switching behavior by orange juice consumers is extremely common and brand loyalty is relatively uncommon especially among consumers of frozen orange juice. When the frequency of sales rises, fewer consumers of orange juice remain loyal to a national brand and switching behavior increases. Looking only within frozen or within refrigerated juices provides a misleading picture that there is more loyalty than when we take account of switching between types.

Demographic characteristics are more likely to be statistically significant than economically significant. As household income rises, consumers are more likely to be loyal to a national brand, less likely to be loyal to a private label, and less likely to switch. Larger households are more likely to buy a private label. Perhaps surprisingly, renters and younger consumers are more likely to be brand loyal than others.

Perhaps our most unusual result, which has not been discussed in either theoretical or empirical papers, is that consumers are very willing to switch between frozen and refrigerated orange juice. By failing to notice these more complicated substitution patterns across types of products, firms and researchers may conclude that consumers are more brand loyal than is actually true.

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Table 1
Summary Statistics

| Discrete Variables (Percentage) |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Consumers' Group Membership |  |  | Group1 | Group2 | Group3 | Group4 | Group5 |
|  | Frozen |  | 24.9 | 14.4 | 37.0 | 23.7 |  |
|  | Refrigerated |  | 16.1 | 6.4 | 12.9 | 64.5 |  |
|  | Combined |  | 3.5 | 6.7 | 4.8 | 24.9 | 60.2 |
| Binary Explanatory Variables | Frozen |  |  | Refrigerated |  | Combined |  |
| No frozen sales | 34.7 |  |  |  |  | 37.5 |  |
| No refrigerated sales |  |  |  | 23.0 |  | 24.3 |  |
| Income exceeding \$100,000 | 1.3 |  |  | 1.8 |  | 1.6 |  |
| Presence of young kids | 11.4 |  |  | 9.0 |  | 9.5 |  |
| Owns house | 88.2 |  |  | 84.5 |  | 84.8 |  |
| Other Discrete Explanatory Variables |  |  | 1 | 2 | 3 | 4 | 5 |
| Female employment status (1- full time, 2-part time, 3-others) | Frozen |  | 55.7 | 18.9 | 25.5 |  |  |
|  | Refrigerated |  | 56.0 | 17.8 | 26.2 |  |  |
|  | Combined |  | 55.7 | 17.8 | 26.6 |  |  |
| $\begin{array}{\|\|l\|} \hline \text { Male employment status } \\ \text { (1- full time, 2-part time, } 3 \text {-others) } \end{array}$ | Frozen |  | 55.6 | 3.2 | 41.2 |  |  |
|  | Refrigerated |  | 52.7 | 3.0 | 44.3 |  |  |
|  | Combined |  | 52.6 | 3.1 | 44.4 |  |  |
| Female Occupation <br> (1-White-collar, 2 -Blue-collar, 3-others)$\|$ | Frozen |  | 44.9 | 9.4 | 45.7 |  |  |
|  | Refrigerated |  | 45.3 | 8.3 | 46.4 |  |  |
|  | Combined |  | 44.6 | 8.4 | 46.9 |  |  |
| Male Occupation <br> (1-White-collar, 2-Blue-collar, 3-others) | Frozen |  | 39.9 | 16.9 | 43.2 |  |  |
|  | Refrigerated |  | 37.1 | 16.4 | 46.5 |  |  |
|  | Combined |  | 37.1 | 16.3 | 46.6 |  |  |
| Female Education (1-no college, 2-college, 3-grad school, 4-tech school, 5-others) | Frozen |  | 34.0 | 35.2 | 22.8 | 6.5 | 1.6 |
|  | Refrigerated |  | 39.5 | 31.8 | 19.4 | 6.9 | 2.3 |
|  | Combined |  | 38.6 | 32.3 | 19.9 | 6.9 | 2.2 |
| Male Education (1-no college, 2-college, 3-grad school, 4-tech school, 5-others) | Frozen |  | 23.2 | 28.4 | 20.6 | 10.0 | 17.8 |
|  | Refrigerated |  | 26.8 | 25.1 | 17.5 | 9.0 | 21.5 |
|  | Combined |  | 26.3 | 25.5 | 17.8 | 9.2 | 21.2 |
| Continuous Explanatory Variables |  |  |  |  |  |  |  |
|  |  | Frozen |  | Refrigerated |  | Combined |  |
|  |  | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| Frozen sales frequency (percentage) |  | 0.6 | 0.9 |  |  | 0.6 | 0.9 |
| Refrigerated sales frequency (percentage) |  |  |  | 1.4 | 2.2 | 1.3 | 2.1 |
| Midpoint of household income bracket (\$1,000) |  | 39.5 | 21.4 | 39.7 | 23.1 | 39.4 | 22.9 |
| Household Size (number) |  | 2.9 | 1.4 | 2.8 | 1.3 | 2.8 | 1.3 |
| Age of male head (years) |  | 43.5 | 24.9 | 42.5 | 26.4 | 42.6 | 26.3 |
| Age of female head (years) |  | 52.7 | 16.2 | 53.4 | 16.7 | 53.3 | 16.7 |
| \# Observations |  | 12,310 |  | 45,047 |  | 54,960 |  |

Table 2
Likelihood Ratio Hypothesis Tests

|  | Degrees of Freedom |  | Full Model |  |  | Restricted Model |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{gathered} \text { Frozen } \\ \text { \& Refrig. } \\ \hline \end{gathered}$ | Comb. | Frozen | Refrig. | Combined | Frozen | Refrig. | Combined |
| Sales (frequency \& dummy) | 6 | 16 | 124.49 | 184.30 | 1359.39 | NA | NA | NA |
| Income (midpoint \& dummy) | 6 | 8 | 66.08 | 157.60 | 108.23 | 66.12 | 161.11 | 114.40 |
| Household size | 3 | 4 | 42.84 | 92.39 | 52.79 | 42.76 | 93.11 | 51.23 |
| Presence of young kids | 3 | 4 | 35.59 | 4.25 | 47.27 | 34.20 | 4.80 | 46.72 |
| Age of male head | 3 | 4 | 2.97 | 7.73 | 37.03 | 3.01 | 7.69 | 36.20 |
| Age of female head | 3 | 4 | 1.02 | 40.27 | 8.37 | 1.29 | 44.70 | 10.43 |
| Male employment status | 6 | 8 | 8.20 | 16.56 | 13.36 | 8.30 | 17.73 | 15.10 |
| Female employment status | 6 | 8 | 15.03 | 10.21 | 19.51 | 15.27 | 10.47 | 19.53 |
| Male Occupation | 6 | 8 | 7.39 | 10.81 | 4.33 | 7.62 | 11.90 | 5.30 |
| Female Occupation | 6 | 8 | 12.67 | 9.50 | 24.55 | 12.52 | 9.87 | 25.18 |
| Male Education | 12 | 16 | 8.35 | 11.07 | 66.39 | 8.51 | 11.00 | 66.01 |
| Female Education | 12 | 16 | 35.17 | 27.91 | 97.26 | 34.91 | 28.79 | 102.55 |
| Race | 6 | 8 | 12.56 | 35.87 | 90.83 | 12.58 | 32.41 | 86.91 |
| Own house | 3 | 4 | 9.70 | 13.28 | 13.28 | 10.48 | 10.91 | 9.59 |
| City fixed effects | 30/69* | 92 | 1480.87 | 6737.87 | 4817.60 | 1967.25 | 7262.71 | 5291.15 |
| All slope coefficients for restricted models | 108/147 | 196 | NA | NA | NA | 2365.44 | 9694.65 | 7423.97 |
| All slope coefficients for full models | 114/153* | 212 | 2492.16 | 9892.81 | 8867.94 | NA | NA | NA |
| Pseudo R2 |  |  | 0.0759 | 0.1080 | 0.0737 | 0.0720 | 0.1058 | 0.0617 |

*The number before the slash is the degrees of freedom for the frozen sample, and the one after the slash is that for the refrigerated sample.
Note: Bold indicates that we can reject at the 0.05 level the null hypothesis that the coefficients for this category are collectively zero.

Table 3
Refrigerated Orange Juice Switching Behavior

| Group | 1 | 2 | 3 | 4 |
| :--- | :---: | :---: | :---: | :---: |
| Probability that a typical household belongs to a given |  |  |  |  |
| group | 0.076 | 0.058 | 0.130 | 0.736 |
| Sales frequency (percentage) |  |  |  |  |
| 0 | 0.080 | 0.059 | 0.152 | 0.709 |
| 1 | 0.079 | 0.058 | 0.132 | 0.732 |
| L | 0.053 | 0.058 | 0.109 | 0.780 |
| 10 | 0.032 | 0.056 | 0.084 | 0.828 |
| 15 | 0.018 | 0.054 | 0.063 | 0.864 |
| Age |  |  |  |  |
| Age of female head is 25 | 0.089 | 0.065 | 0.146 | 0.700 |
| Age of female head is 55 | 0.076 | 0.057 | 0.129 | 0.738 |
| Age of male head is 25 | 0.081 | 0.060 | 0.131 | 0.728 |
| Age of male head is 55 | 0.073 | 0.056 | 0.129 | 0.742 |
| Household Size |  |  |  |  |
| Household size is 2 | 0.083 | 0.054 | 0.128 | 0.735 |
| Household size is 5 | 0.061 | 0.071 | 0.133 | 0.735 |
| Income |  |  |  |  |
| Household annual income is \$30,000 | 0.071 | 0.063 | 0.130 | 0.736 |
| Household annual income is \$50,000 | 0.082 | 0.053 | 0.130 | 0.735 |
| Household annual income exceeds $\$ 100,000$ | 0.133 | 0.030 | 0.132 | 0.705 |
| House ownership |  |  |  |  |
| Owns | 0.076 | 0.058 | 0.130 | 0.736 |
| Rent | 0.082 | 0.067 | 0.138 | 0.714 |
| Presence of young children |  |  |  |  |
| Children under six years old | 0.084 | 0.055 | 0.131 | 0.730 |
| No children under six | 0.076 | 0.058 | 0.130 | 0.736 |
| Female Education |  |  |  |  |
| No college | 0.076 | 0.058 | 0.130 | 0.736 |
| College | 0.077 | 0.057 | 0.132 | 0.733 |
| Grad school | 0.079 | 0.054 | 0.134 | 0.734 |
| Technology School | 0.072 | 0.050 | 0.135 | 0.742 |
| No female head | 0.050 | 0.069 | 0.101 | 0.780 |
| Race | $\mathbf{s}$ |  |  |  |
| White | 0.076 | 0.058 | 0.130 | 0.736 |
| Black | 0.066 | 0.059 | 0.116 | 0.769 |
| Hispanic | 0.071 | 0.043 | 0.131 | 0.752 |
| Others |  |  |  |  |
|  |  | 0.781 |  |  |

Table 4
Frozen Orange Juice Switching Behavior

| Group | 1 | 2 | 3 | 4 |
| :---: | :---: | :---: | :---: | :---: |
| Probability of a typical household | 0.181 | 0.141 | 0.513 | 0.165 |
| Sales frequency (percentage) |  |  |  |  |
| 0 | 0.199 | 0.123 | 0.569 | 0.109 |
| 1 | 0.178 | 0.141 | 0.533 | 0.148 |
| 5 | 0.133 | 0.121 | 0.699 | 0.047 |
| 10 | 0.078 | 0.085 | 0.828 | 0.009 |
| 15 | 0.042 | 0.055 | 0.902 | 0.002 |
| Household size |  |  |  |  |
| Household size is 2 | 0.199 | 0.133 | 0.510 | 0.158 |
| Household size is 5 | 0.144 | 0.163 | 0.515 | 0.179 |
| Income |  |  |  |  |
| Household annual income is \$30,000. | 0.166 | 0.144 | 0.524 | 0.166 |
| Household annual income is \$50,000. | 0.199 | 0.138 | 0.500 | 0.163 |
| Household annual income exceeds \$100,000 | 0.274 | 0.088 | 0.474 | 0.164 |
| House ownership |  |  |  |  |
| Own | 0.181 | 0.141 | 0.513 | 0.165 |
| Rent | 0.209 | 0.154 | 0.490 | 0.147 |
| Presence of young children |  |  |  |  |
| Children under six years old | 0.240 | 0.112 | 0.519 | 0.129 |
| No children under six | 0.181 | 0.141 | 0.513 | 0.165 |
| Female Occupation |  |  |  |  |
| White-collar | 0.181 | 0.141 | 0.513 | 0.165 |
| Blue-collar | 0.177 | 0.145 | 0.508 | 0.169 |
| Other | 0.201 | 0.132 | 0.477 | 0.191 |
| Female Education |  |  |  |  |
| No-college | 0.184 | 0.141 | 0.508 | 0.167 |
| College | 0.181 | 0.141 | 0.513 | 0.165 |
| Grad school | 0.144 | 0.135 | 0.545 | 0.176 |
| Technology school | 0.163 | 0.130 | 0.551 | 0.157 |
| No female head | 0.115 | 0.227 | 0.510 | 0.149 |

Table 4
Combined Sample Switching Behavior

| Group | 1 | 2 | 3 | 4 | 5 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Probability of a typical household | 0.007 | 0.053 | 0.008 | 0.368 | 0.563 |
| Sales frequency |  |  |  |  |  |
| Both sales frequency at |  |  |  |  |  |
| 0 | 0.013 | 0.074 | 0.016 | 0.486 | 0.411 |
| 0.5 | 0.007 | 0.056 | 0.008 | 0.352 | 0.578 |
| 1 | 0.006 | 0.052 | 0.007 | 0.334 | 0.601 |
| 5 | 0.004 | 0.026 | 0.006 | 0.204 | 0.760 |
| 10 | 0.002 | 0.010 | 0.003 | 0.096 | 0.889 |
| 15 | 0.001 | 0.003 | 0.002 | 0.041 | 0.953 |
| Sales frequency of refrigerated fixed at 0.1\%, while that of frozen orange juice is |  |  |  |  |  |
| 0.5 | 0.010 | 0.070 | 0.010 | 0.402 | 0.508 |
| 1 | 0.011 | 0.068 | 0.011 | 0.417 | 0.494 |
| 5 | 0.016 | 0.049 | 0.016 | 0.538 | 0.380 |
| 10 | 0.026 | 0.030 | 0.024 | 0.672 | 0.248 |
| 15 | 0.011 | 0.065 | 0.012 | 0.432 | 0.480 |
| Sales frequency of frozen fixed at 0.1\%, while that of refrigerated orange juice is |  |  |  |  |  |
| 0.5 | 0.009 | 0.061 | 0.012 | 0.437 | 0.481 |
| 1 | 0.008 | 0.059 | 0.011 | 0.404 | 0.519 |
| 5 | 0.003 | 0.037 | 0.005 | 0.175 | 0.780 |
| 10 | 0.001 | 0.015 | 0.001 | 0.044 | 0.938 |
| 15 | 0.000 | 0.006 | 0.000 | 0.010 | 0.984 |
| Age |  |  |  |  |  |
| Age of female head is 25 | 0.007 | 0.059 | 0.008 | 0.370 | 0.555 |
| Age of female head is 55 | 0.007 | 0.052 | 0.008 | 0.368 | 0.564 |
| Age of male head is 25 | 0.007 | 0.053 | 0.009 | 0.344 | 0.587 |
| Age of male head is 55 | 0.007 | 0.053 | 0.007 | 0.385 | 0.547 |
| Household size |  |  |  |  |  |
| Household size is 2 | 0.008 | 0.056 | 0.008 | 0.377 | 0.552 |
| Household size is 5 | 0.006 | 0.046 | 0.008 | 0.344 | 0.595 |
| Income |  |  |  |  |  |
| Household annual income is \$30,000 | 0.007 | 0.051 | 0.009 | 0.362 | 0.571 |
| Household annual income is \$50,000 | 0.007 | 0.055 | 0.007 | 0.376 | 0.555 |
| Household income exceeds \$100,000 | 0.005 | 0.058 | 0.003 | 0.344 | 0.590 |
| House ownership |  |  |  |  |  |
| Own | 0.007 | 0.053 | 0.008 | 0.368 | 0.563 |
| Rent | 0.007 | 0.056 | 0.007 | 0.352 | 0.577 |
| Presence of young children |  |  |  |  |  |
| Children under six years old | 0.011 | 0.052 | 0.010 | 0.324 | 0.603 |
| No children under six | 0.007 | 0.053 | 0.008 | 0.368 | 0.563 |
| Female Occupation |  |  |  |  |  |
| White-collar | 0.007 | 0.053 | 0.008 | 0.368 | 0.563 |
| Blue-collar | 0.009 | 0.051 | 0.010 | 0.365 | 0.566 |
| Others | 0.008 | 0.052 | 0.009 | 0.344 | 0.587 |


| Race |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| White | 0.007 | 0.053 | 0.008 | 0.368 | 0.563 |
| Black | 0.002 | 0.048 | 0.003 | 0.430 | 0.516 |
| Hispanic | 0.004 | 0.054 | 0.006 | 0.405 | 0.531 |
| Others | 0.003 | 0.042 | 0.006 | 0.392 | 0.556 |

## Appendix I <br> Multinomial Logit Results

Table A1.1
Refrigerated Orange Juice Multinomial Regression Results (coefficients in first row; asymptotic standard errors in second row)

|  | FULL MODEL |  |  | RESTRICTED MODEL |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | LR statistic=198 |  |  | p -value=0 |  |  |
|  | Number of obs. $=45,047$ |  |  | Number of obs. $=45,047$ |  |  |
|  | Pseudo $\mathrm{R}^{2}=0.1080$ |  |  | Pseudo $\mathrm{R}^{2}=0.1058$ |  |  |
|  | Log likelihood $=-40858.155$ |  |  | Log likelihood $=-40957.231$ |  |  |
| Group (base is Group 4) | 1 | 2 | 3 | 1 | 2 | 3 |
| Sales frequency | -11.680 | -1.708 | -6.447 |  |  |  |
|  | 0.965 | 1.537 | 1.115 |  |  |  |
| No sales dummy | -0.083 | 0.032 | 0.106 |  |  |  |
|  | 0.037 | 0.058 | 0.041 |  |  |  |
| Midpoint of household Income | 0.007 | -0.008 | 0.000 | 0.007 | -0.008 | 0.000 |
|  | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Household income > \$100,000 | 0.873 | -0.921 | 0.059 | 0.887 | -0.920 | 0.060 |
|  | 0.105 | 0.222 | 0.133 | 0.105 | 0.222 | 0.133 |
| Household size | -0.102 | 0.090 | 0.012 | -0.103 | 0.090 | 0.011 |
|  | 0.014 | 0.019 | 0.014 | 0.014 | 0.019 | 0.014 |
| Presence of young children | 0.099 | -0.039 | 0.019 | 0.107 | -0.037 | 0.027 |
|  | 0.052 | 0.077 | 0.057 | 0.052 | 0.077 | 0.057 |
| Age of male head | -0.004 | -0.003 | -0.001 | -0.004 | -0.003 | -0.001 |
|  | 0.001 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 |
| Age of female head | -0.007 | -0.006 | -0.006 | -0.008 | -0.006 | -0.006 |
|  | 0.001 | 0.002 | 0.001 | 0.001 | 0.002 | 0.001 |
| Male head employed full time | 0.160 | 0.115 | 0.248 | 0.164 | 0.118 | 0.254 |
|  | 0.104 | 0.136 | 0.104 | 0.104 | 0.136 | 0.103 |
| Male head employed part time | -0.080 | -0.007 | 0.039 | -0.086 | -0.007 | 0.037 |
|  | 0.135 | 0.183 | 0.138 | 0.135 | 0.182 | 0.138 |
| Female head employed full time | 0.064 | 0.175 | 0.068 | 0.068 | 0.175 | 0.067 |
|  | 0.051 | 0.075 | 0.056 | 0.051 | 0.075 | 0.056 |
| Female head employed part time | 0.087 | 0.125 | 0.004 | 0.097 | 0.126 | 0.006 |
|  | 0.066 | 0.096 | 0.072 | 0.066 | 0.096 | 0.072 |
| Male head has white-collar job | -0.006 | -0.140 | -0.115 | -0.002 | -0.141 | -0.119 |
|  | 0.100 | 0.131 | 0.099 | 0.100 | 0.131 | 0.099 |
| Male head has blue-collar job | -0.121 | -0.152 | -0.198 | -0.124 | -0.155 | -0.205 |
|  | 0.102 | 0.132 | 0.101 | 0.102 | 0.132 | 0.101 |
| Female head has white-collar job | -0.049 | 0.070 | 0.036 | -0.057 | 0.068 | 0.034 |
|  | 0.041 | 0.060 | 0.045 | 0.041 | 0.060 | 0.045 |
| Female head has blue-collar job | -0.156 | 0.071 | 0.039 | -0.158 | 0.070 | 0.041 |
|  | 0.064 | 0.084 | 0.065 | 0.064 | 0.084 | 0.065 |
| Male head has no college | 0.014 | 0.145 | -0.063 | 0.005 | 0.145 | -0.061 |


|  | 0.115 | 0.161 | 0.125 | 0.115 | 0.161 | 0.125 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Male head has some college | -0.053 | 0.069 | -0.164 | -0.058 | 0.069 | -0.163 |
|  | 0.114 | 0.161 | 0.125 | 0.114 | 0.161 | 0.125 |
| Male head has some grad school | -0.055 | 0.113 | -0.092 | -0.057 | 0.115 | -0.088 |
|  | 0.117 | 0.166 | 0.128 | 0.117 | 0.166 | 0.128 |
| Male head went to technology school | 0.000 | 0.165 | -0.122 | -0.003 | 0.166 | -0.121 |
|  | 0.123 | 0.180 | 0.137 | 0.123 | 0.180 | 0.137 |
| Female head has no college | 0.483 | -0.123 | 0.313 | 0.494 | -0.120 | 0.317 |
|  | 0.127 | 0.169 | 0.136 | 0.127 | 0.169 | 0.136 |
| Female head has some college | 0.499 | -0.135 | 0.334 | 0.516 | -0.131 | 0.337 |
|  | 0.126 | 0.168 | 0.135 | 0.126 | 0.168 | 0.135 |
| Female head has some grad school | 0.513 | -0.196 | 0.349 | 0.533 | -0.192 | 0.353 |
|  | 0.127 | 0.171 | 0.137 | 0.127 | 0.171 | 0.137 |
| Female head went to technology school | 0.420 | -0.270 | 0.344 | 0.447 | -0.264 | 0.350 |
|  | 0.135 | 0.189 | 0.146 | 0.135 | 0.189 | 0.146 |
| White | 0.135 | 0.353 | 0.270 | 0.136 | 0.355 | 0.266 |
|  | 0.101 | 0.205 | 0.119 | 0.100 | 0.205 | 0.119 |
| Black | -0.236 | 0.331 | 0.115 | -0.213 | 0.342 | 0.134 |
|  | 0.120 | 0.218 | 0.133 | 0.120 | 0.218 | 0.133 |
| Hispanic | -0.040 | 0.219 | 0.258 | -0.046 | 0.219 | 0.254 |
|  | 0.122 | 0.246 | 0.140 | 0.122 | 0.246 | 0.140 |
| House owner | -0.098 | -0.172 | -0.088 | -0.075 | -0.166 | -0.081 |
|  | 0.042 | 0.060 | 0.044 | 0.042 | 0.060 | 0.044 |

Notes: Group 4 is the based group. The city dummies and the constant are not reported.

|  |  | actual group membership |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Full Model |  |  |  |
|  |  | 1 | 2 | 3 | 4 |
|  | 1 | 1124 | 87 | 562 | 656 |
|  | 2 | 17 | 119 | 66 | 75 |
|  | 3 | 161 | 46 | 205 | 120 |
|  | 4 | 5943 | 2639 | 4984 | 28243 |
|  |  | Restricted Model |  |  |  |
|  | 1 | 1105 | 89 | 536 | 663 |
|  | 2 | 17 | 121 | 67 | 80 |
|  | 3 | 153 | 43 | 213 | 101 |
|  | 4 | 5970 | 2638 | 5001 | 28250 |

Table A1.2
Frozen Multinomial Regression Results
(coefficient in first row; asymptotic standard errors in second row)

|  | FULL MODEL |  |  | RESTRICTED MODEL |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | LR statistic $=126$ |  |  | p -value=0 |  |  |
|  | Number of obs. $=12310$ |  |  | Number of obs. $=12310$ |  |  |
|  | Log likelihood $=-15182.003$ |  |  | Log likelihood $=-15245.362$ |  |  |
|  | Pseudo $\mathrm{R}^{2}=0.0759$ |  |  | Pseudo $\mathrm{R}^{2}=0.0720$ |  |  |
| Variables | Group1 | Group2 | Group3 | Group1 | Group2 | Group3 |
| Sales Frequency | -14.096 | -10.491 | -35.678 |  |  |  |
|  | 3.957 | 74.999 | 4.391 |  |  |  |
| No Sales Dummy | -0.093 | -0.306 | -0.728 |  |  |  |
|  | 0.070 | 0.082 | 0.076 |  |  |  |
| Midpoint of Household income | 0.011 | 10.000 | 0.001 | . 0.011 | 0.000 | 0.001 |
|  | 0.002 | 20.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| Household income > \$100,000 | 0.937 | -0.385 | 0.124 | 0.942 | -0.365 | 0.169 |
|  | 0.225 | - 0.326 | 0.240 | 0.225 | 0.326 | 0.240 |
| Household Size | -0.112 | 20.066 | 0.039 | -0.110 | 0.066 | 0.041 |
|  | 0.025 | - 0.028 | 0.025 | - 0.025 | 0.028 | 0.025 |
| Presence of young children | 0.271 | -0.243 | -0.255 | 0.272 | -0.235 | -0.240 |
|  | 0.086 | 0.108 | 0.093 | - 0.086 | 0.108 | 0.092 |
| Age of male head | -0.003 | 0.002 | -0.001 | -0.003 | 0.003 | -0.001 |
|  | 0.003 | 30.003 | 0.003 | - 0.003 | 0.003 | 0.003 |
| Age of female head | -0.003 | -0.001 | -0.001 | -0.003 | -0.002 | -0.002 |
|  | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | -0.003 |
| Male head employed full time | -0.076 | - 0.148 | -0.092 | - -0.077 | 0.149 | -0.089 |
|  | 0.197 | - 0.196 | 0.191 | - 0.196 | 0.196 | 0.190 |
| Male head employed part-time | -0.415 | 0.043 | -0.015 | -0.419 | 0.045 | -0.011 |
|  | 0.244 | 40.252 | 0.232 | - 0.244 | 0.252 | - 0.230 |
| Female head employed full time | 0.157 | 7 0.144 | 0.001 | - 0.154 | 0.143 | -0.003 |
|  | 0.091 | - 0.106 | 0.092 | 2.091 | 0.106 | 0.092 |
| Female head employed part-time | 0.137 | 0.052 | 0.174 | 0.138 | 0.050 | 0.174 |
|  | 0.117 | - 0.137 | 0.118 | - 0.117 | 0.137 | 0.118 |
| Male head has white-collar job | 0.200 | -0.250 | 0.067 | 0.202 | -0.243 | - 0.072 |
|  | 0.190 | 0.188 | 0.185 | 0.189 | 0.188 | 0.184 |
| Male head has blue-collar job | 0.168 | -0.370 | -0.007 | - 0.167 | -0.369 | -0.013 |
|  | 0.192 | 0.191 | 0.187 | - 0.191 | 0.191 | - 0.186 |
| Female head has white-collar job | -0.175 | -0.003 | -0.221 | -0.173 | 0.000 | -0.217 |
|  | 0.074 | 0.088 | 0.077 | - 0.073 | 0.088 | 0.076 |
| Female head has blue-collar job | -0.188 | 0.034 | -0.183 | -0.186 | 0.042 | -0.171 |
|  | 0.106 | 0.119 | 0.108 | - 0.106 | 0.119 | 0.107 |
| Male head has no college education | -0.079 | -0.106 | 0.187 | -0.087 | -0.125 | 0.170 |
|  | 0.213 | 0.237 | 0.212 | - 0.213 | 0.237 | 0.211 |
| Male head has some college | -0.059 | -0.141 | 0.155 | -0.066 | -0.158 | - 0.135 |
|  | 0.211 | 0.235 | 0.210 | 0.211 | 0.235 | 0.209 |


| Male head has some grad school | -0.033 | -0.299 | 0.115 | -0.041 | -0.318 | 0.091 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0.216 | 0.242 | 0.216 | 0.216 | 0.242 | 0.215 |
|  | -0.012 | -0.213 | 0.203 | -0.020 | -0.226 | 0.189 |
|  | 0.226 | 0.255 | 0.226 | 0.225 | 0.255 | 0.225 |
| Female head has no college education | 0.477 | -0.476 | 0.116 | 0.493 | -0.471 | 0.154 |
|  | 0.251 | 0.263 | 0.246 | 0.251 | 0.262 | 0.245 |
| Female head has some college | 0.451 | -0.481 | 0.096 | 0.464 | -0.476 | 0.135 |
|  | 0.249 | 0.260 | 0.245 | 0.249 | 0.260 | 0.243 |
| Female head has some grad school | 0.162 | -0.586 | 0.104 | 0.177 | -0.586 | 0.133 |
|  | 0.253 | 0.265 | 0.248 | 0.253 | 0.265 | 0.247 |
| Female head went to technology | 0.272 | -0.633 | -0.024 | 0.290 | -0.628 | 0.017 |
| school | 0.268 | 0.286 | 0.265 | 0.268 | 0.286 | 0.263 |
| White | 0.036 | 0.375 | -0.074 | 0.044 | 0.376 | -0.073 |
|  | 0.241 | 0.291 | 0.249 | 0.241 | 0.290 | 0.248 |
| Black | -0.184 | 0.286 | 0.235 | -0.169 | 0.294 | 0.241 |
|  | 0.289 | 0.338 | 0.292 | 0.289 | 0.338 | 0.290 |
| Hispanic | -0.202 | 0.160 | 0.112 | -0.198 | 0.166 | 0.112 |
|  | 0.290 | 0.330 | 0.294 | 0.290 | 0.330 | 0.292 |
| House owner | -0.189 | -0.132 | 0.064 | -0.189 | -0.122 | 0.083 |
|  | 0.081 | 0.092 | 0.087 | 0.081 | 0.092 | 0.087 |

Notes: Group 3 is the base group. The constant and city dummies are not reported.

|  |  | actual group membership |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Full Model |  |  |  |
|  |  | 1 | 2 | 3 | 4 |
|  | 1 | 1151 | 235 | 741 | 460 |
|  | 2 | 40 | 142 | 97 | 97 |
|  | 3 | 1231 | 956 | 2805 | 943 |
|  | 4 | 636 | 446 | 914 | 1416 |
|  |  | Restricted Model |  |  |  |
|  | 1 | 1181 | 238 | 762 | 469 |
|  | 2 | 41 | 144 | 101 | 101 |
|  | 3 | 1189 | 843 | 2646 | 858 |
|  | 4 | 647 | 554 | 1048 | 1488 |

Table A1.3
Combined Multinomial Regression Results
(coefficient in first row; asymptotic standard errors in second row)

|  | Full Model |  |  |  | Restricted Model |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | LR statistic $=1443$ |  |  |  | p -value=0 |  |  |  |
|  | Number of obs $=54960$ |  |  |  | Number of obs $=54960$ |  |  |  |
|  | Log likelihood $=-55755.945$ |  |  |  | Log likelihood $=-56477.933$ |  |  |  |
|  | Pseudo R2 |  | = 0.0737 |  | Pseudo R2 |  | = 0.0617 |  |
|  | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Frozen sales frequency | -36.504 | -21.452 | -29.220 | -31.152 |  |  |  |  |
|  | 5.016 | 2.628 | 4.246 | 1.645 |  |  |  |  |
| No frozen sales | 0.350 | 0.247 | 0.307 | 0.108 |  |  |  |  |
|  | 0.067 | 0.051 | 0.059 | 0.031 |  |  |  |  |
| Refrigerated sales frequency | 17.494 | -1.299 | 16.391 | 12.941 |  |  |  |  |
|  | 2.574 | 1.368 | 2.204 | 0.736 |  |  |  |  |
| No refrigerated sales | 0.593 | 0.257 | 0.704 | 0.467 |  |  |  |  |
|  | 0.059 | 0.047 | 0.053 | 0.030 |  |  |  |  |
| Midpoint of household Income | -0.002 | 0.005 | -0.008 | 0.003 | -0.002 | 0.006 | -0.008 | 0.003 |
|  | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 |
| Household income > \$100,000 | -0.438 | 0.259 | -1.239 | 0.016 | -0.487 | 0.246 | -1.295 | -0.024 |
|  | 0.237 | 0.151 | 0.246 | 0.098 | 0.236 | 0.150 | 0.245 | 0.097 |
| Household size | -0.088 | -0.088 | -0.013 | -0.056 | -0.086 | -0.087 | -0.011 | -0.054 |
|  | 0.025 | 0.018 | 0.021 | 0.011 | 0.025 | 0.018 | 0.021 | 0.010 |
| Presence of young Children | 0.377 | -0.076 | 0.124 | -0.197 | 0.379 | -0.070 | 0.126 | -0.193 |
|  | 0.088 | 0.068 | 0.076 | 0.043 | 0.087 | 0.068 | 0.076 | 0.043 |
| Age of male head | 0.002 | 0.002 | -0.005 | 0.006 | 0.002 | 0.002 | -0.005 | 0.006 |
|  | 0.003 | 0.002 | 0.002 | 0.001 | 0.003 | 0.002 | 0.002 | 0.001 |
| Age of female head | -0.001 | -0.005 | -0.002 | -0.001 | -0.002 | -0.005 | -0.002 | -0.001 |
|  | 0.002 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.002 | 0.001 |
| Male head employed full time | -0.123 | 0.200 | -0.081 | 0.158 | -0.097 | 0.222 | -0.055 | 0.178 |
|  | 0.183 | 0.125 | 0.150 | 0.075 | 0.182 | 0.125 | 0.150 | 0.074 |
| Male head employed part time | -0.121 | -0.003 | 0.108 | 0.168 | -0.099 | 0.007 | 0.137 | 0.188 |
|  | 0.229 | 0.169 | 0.186 | 0.096 | 0.228 | 0.168 | 0.185 | 0.095 |
| Female head employed full time | -0.001 | 0.118 | -0.147 | -0.031 | -0.009 | 0.112 | -0.152 | -0.037 |
|  | 0.085 | 0.065 | 0.076 | 0.038 | 0.085 | 0.064 | 0.075 | 0.037 |
| Female head employed part time | 0.050 | -0.022 | -0.125 | -0.098 | 0.047 | -0.022 | -0.127 | -0.103 |
|  | 0.112 | 0.085 | 0.098 | 0.050 | 0.112 | 0.084 | 0.098 | 0.049 |
| Male head has white-collar job | 0.074 | -0.064 | -0.031 | -0.105 | 0.044 | -0.079 | -0.061 | -0.125 |
|  | 0.178 | 0.121 | 0.145 | 0.073 | 0.178 | 0.120 | 0.145 | 0.072 |
| Male head has blue-collar Job | 0.096 | -0.123 | -0.070 | -0.112 | 0.072 | -0.140 | -0.092 | -0.126 |
|  | 0.182 | 0.123 | 0.148 | 0.074 | 0.182 | 0.123 | 0.147 | 0.073 |
| Female head has white-collar job | -0.117 | 0.049 | -0.027 | 0.111 | -0.114 | 0.049 | -0.026 | 0.116 |
|  | 0.073 | 0.052 | 0.064 | 0.032 | 0.072 | 0.052 | 0.064 | 0.032 |
| Female head has | 0.048 | 0.007 | 0.169 | 0.096 | 0.044 | 0.011 | 0.162 | 0.104 |


| blue-collar job | 0.104 | 0.078 | 0.088 | 0.047 | 0.104 | 0.078 | 0.087 | 0.047 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Male head has no college | -0.131 | -0.303 | 0.449 | -0.396 | -0.142 | -0.307 | 0.444 | -0.382 |
|  | 0.200 | 0.142 | 0.172 | 0.087 | 0.199 | 0.142 | 0.171 | 0.086 |
| Male head has some College | -0.068 | -0.489 | 0.504 | -0.406 | -0.081 | -0.495 | 0.499 | -0.402 |
|  | 0.198 | 0.142 | 0.171 | 0.087 | 0.197 | 0.142 | 0.170 | 0.086 |
| Male head has some grad school | 0.016 | -0.516 | 0.526 | -0.441 | 0.000 | -0.521 | 0.518 | -0.440 |
|  | 0.203 | 0.146 | 0.175 | 0.089 | 0.202 | 0.145 | 0.175 | 0.088 |
| Male head went to technology school | 0.095 | -0.479 | 0.558 | -0.455 | 0.066 | -0.492 | 0.541 | -0.456 |
|  | 0.213 | 0.155 | 0.185 | 0.095 | 0.213 | 0.155 | 0.184 | 0.094 |
| Female head has no College | -0.008 | -0.366 | 0.475 | -0.254 | 0.022 | -0.343 | 0.510 | -0.241 |
|  | 0.218 | 0.148 | 0.203 | 0.093 | 0.218 | 0.148 | 0.202 | 0.092 |
| Female head has some College | -0.092 | -0.432 | 0.579 | -0.339 | -0.069 | -0.414 | 0.607 | -0.339 |
|  | 0.217 | 0.147 | 0.201 | 0.093 | 0.216 | 0.147 | 0.201 | 0.092 |
| Female head has some grad school | 0.063 | -0.546 | 0.697 | -0.443 | 0.085 | -0.528 | 0.724 | -0.442 |
|  | 0.219 | 0.149 | 0.204 | 0.094 | 0.219 | 0.149 | 0.203 | 0.093 |
| Female head went to technology school | 0.010 | -0.533 | 0.782 | -0.411 | 0.024 | -0.517 | 0.807 | -0.422 |
|  | 0.234 | 0.160 | 0.216 | 0.101 | 0.234 | 0.160 | 0.215 | 0.100 |
| White | 0.734 | 0.210 | 0.268 | -0.075 | 0.738 | 0.215 | 0.273 | -0.078 |
|  | 0.260 | 0.153 | 0.176 | 0.087 | 0.260 | 0.152 | 0.175 | 0.086 |
| Black | -0.246 | 0.212 | -0.514 | 0.169 | -0.225 | 0.245 | -0.494 | 0.154 |
|  | 0.323 | 0.170 | 0.238 | 0.098 | 0.322 | 0.169 | 0.237 | 0.097 |
| Hispanic | 0.260 | 0.293 | 0.030 | 0.080 | 0.288 | 0.293 | 0.062 | 0.091 |
|  | 0.292 | 0.179 | 0.207 | 0.105 | 0.291 | 0.178 | 0.206 | 0.104 |
| House owner | 0.003 | -0.041 | 0.187 | 0.069 | -0.016 | -0.041 | 0.170 | 0.046 |
|  | 0.075 | 0.052 | 0.067 | 0.032 | 0.075 | 0.052 | 0.066 | 0.032 |
|  | 0.356 | 0.268 | 0.300 | 0.173 | 0.352 | 0.265 | 0.296 | 0.170 |

Notes: Group 5 is the base group. The city dummies and the constant are not reported.

|  |  | actual group membership |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Full Model |  |  |  |  |
|  |  | 1 | 2 | 3 | 4 | 5 |
|  | 4 | 46 | 266 | 34 | 1862 | 1565 |
|  | 5 | 1871 | 3426 | 2580 | 11813 | 31497 |
|  |  | Restricted Model |  |  |  |  |
|  | 4 | 12 | 180 | 11 | 874 | 893 |
|  | 5 | 1905 | 3512 | 2603 | 12801 | 32169 |

Note: Predicted memberships are zeros for groups 1, 2, and 3.

## Appendix 2 <br> Simulation Results for the Restricted Models

Table A2.1
Simulation Results for Refrigerated Restricted Model

| Group | 1 | 2 | 3 | 4 |
| :--- | :---: | :---: | :---: | :---: |
| Probability of a typical household | 0.077 | 0.060 | 0.133 | 0.731 |
| Age |  |  |  |  |
| When age of female head is 25 | 0.090 | 0.067 | 0.150 | 0.693 |
| When age of female head is 55 | 0.076 | 0.059 | 0.132 | 0.733 |
| When age of male head is 25 | 0.081 | 0.062 | 0.133 | 0.724 |
| When age of male head is 55 | 0.073 | 0.058 | 0.133 | 0.736 |
| Household Size |  |  |  |  |
| When household size is 2 | 0.083 | 0.055 | 0.132 | 0.730 |
| When household size is 5 | 0.061 | 0.073 | 0.137 | 0.730 |
| Household Income | 0.071 | 0.064 | 0.134 | 0.731 |
| When household annual income is $\$ 30,000$ | 0.083 | 0.055 | 0.133 | 0.730 |
| When household annual income is $\$ 50,000$ | 0.133 | 0.031 | 0.137 | 0.699 |
| When household income exceeds $\$ 100,000$ |  |  |  |  |
| House ownership | 0.077 | 0.060 | 0.133 | 0.731 |
| Own | 0.080 | 0.068 | 0.141 | 0.711 |
| Rent |  |  |  |  |
| Presence of young children | 0.084 | 0.057 | 0.136 | 0.723 |
| Children under six years old | 0.077 | 0.060 | 0.133 | 0.731 |
| No children younger than six |  |  |  |  |
| Employment status of male head | 0.077 | 0.060 | 0.133 | 0.731 |
| Full-time | 0.063 | 0.055 | 0.113 | 0.769 |
| Part-time | 0.068 | 0.056 | 0.109 | 0.767 |
| Others |  |  |  |  |
| Employment status of female head | 0.077 | 0.060 | 0.133 | 0.731 |
| Full-time | 0.079 | 0.057 | 0.126 | 0.737 |
| Part-time | 0.073 | 0.051 | 0.128 | 0.748 |
| Others |  |  |  |  |
| Occupation of male head | 0.077 | 0.060 | 0.133 | 0.731 |
| White-collar | 0.069 | 0.060 | 0.125 | 0.746 |
| Blue-collar | 0.075 | 0.067 | 0.146 | 0.712 |
| Others | 0.077 | 0.060 | 0.133 | 0.731 |
| Occupation of female head | 0.070 | 0.060 | 0.135 | 0.735 |
| White-collar | 0.081 | 0.056 | 0.129 | 0.733 |
| Blue-collar | 0.077 | 0.060 | 0.133 | 0.731 |
| Others | 0.073 | 0.056 | 0.123 | 0.747 |
| Education of male head | 0.073 | 0.058 | 0.131 | 0.738 |
| No college |  |  |  |  |
| College |  |  |  |  |
| Grad school |  |  |  |  |
|  |  |  |  |  |


| Technology School | 0.076 | 0.061 | 0.127 | 0.736 |
| :--- | ---: | :--- | :--- | :--- |
| No female head | 0.076 | 0.052 | 0.142 | 0.731 |
| Education of female head |  |  |  |  |
| No college | 0.077 | 0.060 | 0.133 | 0.731 |
| College | 0.078 | 0.059 | 0.136 | 0.728 |
| Grad school | 0.079 | 0.055 | 0.138 | 0.728 |
| Technology School | 0.074 | 0.052 | 0.139 | 0.736 |
| No female head | 0.050 | 0.071 | 0.103 | 0.776 |
| Race |  |  |  |  |
| White | 0.077 | 0.060 | 0.133 | 0.731 |
| Black | 0.056 | 0.061 | 0.122 | 0.761 |
| Hispanic | 0.065 | 0.053 | 0.135 | 0.747 |
| Others | 0.071 | 0.044 | 0.109 | 0.776 |

## Table A2.2 <br> Simulation Results for Frozen Restricted Model

| Group | 1 | 2 | 3 | 4 |
| :--- | :---: | :---: | :---: | :---: |
| The probability of a typical household | 0.193 | 0.129 | 0.549 | 0.129 |
| Age |  |  |  |  |
| When age of female head is 25 | 0.202 | 0.131 | 0.534 | 0.133 |
| When age of female head is 55 | 0.192 | 0.129 | 0.550 | 0.129 |
| When age of male head is 25 | 0.202 | 0.122 | 0.545 | 0.130 |
| When age of male head is 55 | 0.186 | 0.134 | 0.551 | 0.128 |
| Household Size |  |  |  |  |
| When household size is 2 | 0.211 | 0.121 | 0.545 | 0.123 |
| When household size is 5 | 0.154 | 0.150 | 0.554 | 0.142 |
| Household income |  |  |  |  |
| When household annual income is \$30,000 | 0.177 | 0.132 | 0.561 | 0.130 |
| When household annual income is \$50,000 | 0.211 | 0.126 | 0.535 | 0.128 |
| When household income exceeds $\$ 100,000$ | 0.288 | 0.081 | 0.499 | 0.132 |
| House ownership |  |  |  |  |
| Own | 0.193 | 0.129 | 0.549 | 0.129 |
| Rent | 0.222 | 0.140 | 0.525 | 0.113 |
| Presence of young children |  |  |  |  |
| Children under six years old | 0.252 | 0.102 | 0.546 | 0.101 |
| No children under six | 0.193 | 0.129 | 0.549 | 0.129 |
| Employment status of male head |  |  |  |  |
| Full-time | 0.193 | 0.129 | 0.549 | 0.129 |
| Part-time | 0.145 | 0.124 | 0.583 | 0.148 |
| Others | 0.206 | 0.110 | 0.544 | 0.140 |
| Employment status of female head |  |  |  |  |
| Full-time | 0.193 | 0.129 | 0.549 | 0.129 |
| Part-time | 0.188 | 0.117 | 0.543 | 0.152 |
| Others | 0.173 | 0.117 | 0.574 | 0.135 |
| Occupation of male head |  |  |  |  |
| White-collar | 0.193 | 0.129 | 0.549 | 0.129 |
| Blue-collar | 0.192 | 0.118 | 0.567 | 0.123 |
| Others | 0.159 | 0.166 | 0.554 | 0.121 |
| Occupation of female head |  |  |  |  |
| White-collar | 0.193 | 0.129 | 0.549 | 0.129 |
| Blue-collar | 0.188 | 0.134 | 0.544 | 0.134 |
| Others | 0.215 | 0.121 | 0.514 | 0.150 |
| Education of male head | 0.193 | 0.129 | 0.549 | 0.129 |
| No college | 0.201 | 0.113 | 0.560 | 0.126 |
| College | 0.200 | 0.120 | 0.545 | 0.135 |
| Grad school | 0.303 | 0.085 | 0.494 | 0.118 |
| Technology School | 0.149 | 0.539 | 0.111 |  |
| No female head |  |  |  |  |
| Education of female head |  |  |  |  |
|  |  |  |  |  |


| No college | 0.197 | 0.129 | 0.544 | 0.130 |
| :--- | :--- | :--- | :--- | :--- |
| College | 0.193 | 0.129 | 0.549 | 0.129 |
| Grad school | 0.154 | 0.124 | 0.585 | 0.137 |
| Technology School | 0.173 | 0.119 | 0.586 | 0.122 |
| No female head | 0.122 | 0.210 | 0.554 | 0.114 |
| Race |  |  |  |  |
| White | 0.193 | 0.129 | 0.129 | 0.549 |
| Black | 0.156 | 0.119 | 0.177 | 0.549 |
| Hispanic | 0.157 | 0.109 | 0.162 | 0.572 |
| Others | 0.192 | 0.092 | 0.144 | 0.571 |

## Table A2.3 <br> Simulation Results for Combined Restricted Model

| Group | 1 | 2 | 3 | 4 | 5 |
| :--- | :---: | :---: | :---: | :---: | :---: |
| The probability of a typical household | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Age |  |  |  |  |  |
| When age of female head is 25 | 0.009 | 0.066 | 0.010 | 0.392 | 0.522 |
| When age of female head is 55 | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| When age of male head is 25 | 0.009 | 0.058 | 0.011 | 0.367 | 0.555 |
| When age of male head is 55 | 0.009 | 0.058 | 0.009 | 0.408 | 0.516 |
| Household size |  |  |  |  |  |
| When household size is 2 | 0.009 | 0.061 | 0.010 | 0.400 | 0.520 |
| When household size is 5 | 0.008 | 0.051 | 0.010 | 0.368 | 0.563 |
| Income |  |  |  |  |  |
| When household annual income is $\$ 30,000$ | 0.009 | 0.056 | 0.011 | 0.385 | 0.539 |
| When household annual income is $\$ 50,000$ | 0.008 | 0.061 | 0.009 | 0.399 | 0.523 |
| When household income exceeds $\$ 100,000$ | 0.006 | 0.064 | 0.004 | 0.358 | 0.568 |
| House ownership |  |  |  |  |  |
| Own | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Rent | 0.009 | 0.062 | 0.009 | 0.380 | 0.540 |
| Presence of young children |  |  |  |  |  |
| Children under six years old | 0.014 | 0.058 | 0.012 | 0.346 | 0.570 |
| No children under six | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Employment status of male head |  |  |  |  |  |
| Full-time | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Part-time | 0.009 | 0.047 | 0.012 | 0.397 | 0.534 |
| Others | 0.010 | 0.051 | 0.011 | 0.354 | 0.574 |
| Employment status of female head |  |  |  |  |  |
| Full-time | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Part-time | 0.010 | 0.053 | 0.011 | 0.378 | 0.549 |
| Others | 0.009 | 0.052 | 0.011 | 0.402 | 0.526 |
| Occupation of male head |  |  |  |  |  |
| White-collar | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Blue-collar | 0.009 | 0.055 | 0.010 | 0.392 | 0.534 |
| Others | 0.008 | 0.060 | 0.010 | 0.419 | 0.503 |
| Occupation of female head |  |  |  |  |  |
| White-collar | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Blue-collar | 0.010 | 0.056 | 0.012 | 0.388 | 0.533 |
| Others | 0.010 | 0.058 | 0.011 | 0.365 | 0.556 |
| Education of male head | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| No college | 0.009 | 0.049 | 0.011 | 0.390 | 0.541 |
| College | 0.010 | 0.049 | 0.011 | 0.381 | 0.549 |
| Grad school | 0.050 | 0.011 | 0.376 | 0.551 |  |
| Technology School | 0.066 | 0.005 | 0.477 | 0.443 |  |
| No female head |  |  |  |  |  |
|  |  |  |  |  |  |


| Education of female head |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| No college | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| College | 0.008 | 0.057 | 0.011 | 0.370 | 0.554 |
| Grad school | 0.010 | 0.053 | 0.013 | 0.347 | 0.577 |
| Technology School | 0.009 | 0.053 | 0.014 | 0.351 | 0.572 |
| No female head | 0.008 | 0.073 | 0.005 | 0.442 | 0.472 |
| Race |  |  |  |  |  |
| White | 0.009 | 0.058 | 0.010 | 0.391 | 0.532 |
| Black | 0.003 | 0.055 | 0.004 | 0.451 | 0.486 |
| Hispanic | 0.005 | 0.059 | 0.007 | 0.432 | 0.496 |
| Others | 0.004 | 0.047 | 0.007 | 0.417 | 0.524 |


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[^1]:    ${ }^{1}$ Similarly, in many other models, consumers are assumed to have different search costs, making the high-searchcost consumers "loyal" (e.g., Salop and Stiglitz, 1977), or different switching costs (e.g., Grabowski and Vernon, 1992, and Frank and Salkever, 1997).
    ${ }^{2}$ Our results are consistent with a literature that focuses on firm strategies and investments to affect brand loyalty by increasing switching cost across brands (for example, Beggs and Klemperer 1992, Farrell and Shapiro, 1988, Klemperer 1995, Schmalensee and Willig 1986), however, the strategies examined in these models do not seem particularly relevant for orange juice.

[^2]:    ${ }^{3}$ Refrigerated, frozen, and shelf stable orange juice are sold in most stores. We examine consumers' switching behavior for only refrigerated and frozen orange juice because shelf stable sales account for less than 1 percent of the total purchases of orange juice in our household level data.

[^3]:    ${ }^{4}$ The IRI cities are Atlanta; Boston; Cedar Rapids, IA; Chicago; Denver; Detroit; Eau Claire, WI; Grand Junction, CO; Houston; Kansas City; Los Angeles; Memphis; Midland, TX; Minneapolis/St. Paul; New York; Philadelphia; Pittsburgh; Pittsfield, MA; Rome, GA; San Francisco/Oakland; Seattle/Tacoma; St. Louis; Tampa/St. Petersburg; and Visalia, CA.
    ${ }^{5}$ Our definition of loyalty is based on only purchasing one brand during a fixed period of time; however, several alternative approaches have been used in other settings (Jacoby and Kyner, 1973; Jacoby and Chestnut, 1978; Colombo and Morrison, 1989; and Bayus, 1992).
    ${ }^{6}$ It does not include separate categories for those who are loyal to private labels because those categories are extremely small. Through experimentation, we have found that our results are robust to changes in our categorization schemes.

[^4]:    ${ }^{7}$ In some of the 24 IRI sample cities, we do not observe consumers in all four groups for the frozen orange juice sample. We use only the 11 cities for which all four groups are observed: Eau Claire, WI; Midland, TX; Visalia, CA; Cedar Rapids, IA; Memphis; Houston; Pittsburgh; Seattle/Tacoma; Detroit; St. Louis; Kansas City; and Minneapolis/St. Paul.

[^5]:    ${ }^{8}$ We determine the top selling brands using the household level data. Of the five best-selling refrigerated products (UPCs), the first three are Tropicana products, the fourth is produced by Florida Natural, and the final one by Minute Maid. Of the five best-selling frozen UPCs, the first, second, and fifth are Minute Maid products, the third is manufactured by Old Orchard, and the fourth by Tropicana.

[^6]:    ${ }^{9}$ Brand loyalty may be greater in other processed foods (see for example, Villas-Boas, 1995).
    ${ }^{10}$ All the stores carry the leading frozen brand, and virtually all carry one or the other (but not both) of the second and third best-selling frozen brands. It is much more common for stores to carry all three leading refrigerated brands.

[^7]:    11 IRI reports income in ranges and top codes incomes above $\$ 100,000$. Consequently, we use two income measures. One is the midpoint of a household's annual income bracket if its income is less than $\$ 100,000$. The other is a dummy if the income exceeds $\$ 100,000$.

[^8]:    12 Rhea and Bell (2002) report that they fail to find a relationship between consumers’ observable demographics and their decisions to switch between stores after controlling for unobserved heterogeneity. Bell, Ho, and Tang (1998) cite industry research that location explains up to 70 percent of the variance in consumers' supermarket choice decisions.
    ${ }^{13}$ The pseudo $\mathrm{R}^{2}$ is $1-L_{1} / L_{0}$, where $L_{0}$ is the constant-only $\log$ likelihood and $L_{1}$ is the full-model $\log$ likelihood.

[^9]:    ${ }^{14}$ If we allow the sales frequency to rise well outside of the observed range to 40 percent, the share in the first group falls to essentially zero and the share of the fourth group prices to 95 percent.

[^10]:    ${ }^{15}$ A survey of the American Association of Retired Persons found that people aged 65 and older were 15 percent less likely than people aged 45 to 64 to request generic versions of a drug from their doctor or pharmacist ("Generics, the Impact at the Grass Roots," Drug Topics Supplement, 1994). Perhaps in response of legislation and insurance rules that require generics be offered or provided, older citizens have become more accepting of generics recently (research.aarp.org/health/ib61_generic.pdf).

