Determinants of Consumer Choices of Prepared Frozen Meals and Salted Snacks Over Time

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Abstract: We develop and estimate an integrated discrete choice model system of product choice and nutrition information for prepared frozen meals and salted snacks in the United States in the period from 1995 to 1999. The model links consumer observed and latent characteristics (e.g., income, knowledge about nutrition, nutrition label use) to product characteristics (e.g., prices, nutritional attributes) and allows us to obtain consumer preference parameters and demand elasticities with regard to product characteristics. We find that prices, advertising, price reductions, and consumer preferences for taste have a significant effect on the demand for prepared frozen meals, whereas nutrition information and nutrition label use do not. Using the estimated demand parameters we then evaluate the impact of the new mandatory labeling policy. The results show that consumer preferences and purchasing patterns within the prepared frozen meal and the salted snack categories did not change significantly after the implementation of mandatory labeling. [EconLit Q130, L110, L150].

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Introduction

In the past decades, nutrition educators, researchers, and government agencies have highlighted scientific findings that an individual's diet has a direct effect on their personal health. Programs and policies have been created specifically to increase consumer's awareness and understanding of these conditions and to improve their ability to make good food purchasing decisions. Specifically, the United States government implemented mandatory national labeling policy requiring nutrient profiles on all packaged food products. Yet the number of Americans struggling with diet related health problems is rising at faster rate than ever before.

During this time, the per capita income in the United States has increased at a greater rate than the cost of most food products making food more affordable to consumers. As a result of increased income, consumers place a greater value on time and demand convenient food items often at the expense of nutritional quality (Aldrich, 1999). Researchers have found that taste out ranks nutrition in choosing which frozen meal or frankfurter to consume (Mojduszka et al., 2001 and Harris, 1997). It appears as if taste, marketing, rising incomes and convenience are all taking precedence over nutrition and health concerns when consumers make food purchasing decisions.

This paper investigates the determinants of consumers' frozen meal and salted snack choices and develops an empirical understanding of the factors affecting actual product-level food demands. We have chosen to look specifically at prepared frozen meals as they represent a rapidly increasing segment of the home-meal replacement category. Research shows the average American consumes a frozen meal option about six times per month or approximately 74 times during a one year period, a 33% increase since 1992 (NDP, 2002). We have also chosen to study specifically the salted snack category which includes the following sub-categories: potato chips, tortilla chips, crackers, pretzels, popcorn, cheese snacks, breadsticks, and other salted snacks.

Salted snacks are a very important part of the American diet. In 1999, Americans purchased more than 1.1 billion pounds of potato chips, pretzels, and ready to eat popcorn from supermarkets, drug stores, and mass merchandising outlets. In 2000, the salted snacks category amounted to more than eight billion dollars in sales for the industry and grew more than 4.2 percent (Roberts Jr., 2001). The total sales of salted snacks increased six percent from 1995-1999, while sales of regular versions increased 11 percent, yet the sales of lower fat versions decreased 6 percent during the same years (Allshouse et al., 2002).

Salted snacks remain consumers' top choice for snacking and supply about 25 percent of our daily calories (Clyde, Vollmers, and Swenson, 2000). The American Diabetic Association in Chicago reported that approximately 75 percent of consumers had at least one snack per day in 2000 (Berry, 2002). The applicability of the findings of this project reaches far beyond the frozen meal and salted snack segments and will be helpful to policy makers, food processors, and nutrition educators across the food product spectrum.

Consumer Information and the Food Choice Paradox

Consumer information, can take many forms ranging from generic health information to product-specific nutrition profiles. A consumer's ability or desire to utilize information may play an active role in their food purchasing decisions. In this section, we explore the relevant work on particular information issues including information acquisition and nutrition label use.

The government plays a sizeable role in the dissemination of nutritional information, often using governmental studies and scientific panel recommendations as vehicles for release with the popular press casting a broader net with a second-round release. The consumers reached by news and print media absorb this nutrition information disproportionately to the rest of the population. More so, the government release of generic information requires that consumers have other information sources and a greater understanding of the specific health issue in order to develop a behavioral change in response to new information (Ippolito and Mathios, 1990).

Individual's characteristics affect one's acquisition of new information. For example, Shultz (1975) argued that education is an important determinant of an individual's ability to process new information into changed behavior. Becker (1965, 1977) hypothesized that an individual's opportunity value of time and the economies of the household play a significant role in an individual's acquisition of information. More so, Grossman (1972) developed the idea that an individual's valuation of health capital influences their reaction to new health information.

Nutrition labeling is a valuable policy tool in that consumers have no way to evaluate the nutritional quality of their food products on their own. Uncertainty may be reduced through the information provided in nutrition labels (Zarkin and Anderson, 1992). In addition, credence attributes[1] of food products may be transformed into search attributes[2] as a result of the increased information (Caswell and Mojduszka, 1996). The NLEA was designed to provide significant improvements in diet quality by helping consumers make better or healthier food choices.

Much like the acquisition of new information, nutrition label use is not homogenous. Males are reported to be less likely to make frequent use of nutritional labeling than their female counterparts (Guthrie et al., 1998; Bender and Derby, 1992; Nayga, 1996; and Godvindasamy and Italia, 1999). Although women have increased their presence in the work force, they continue to play the lead role in deciding and preparing what American families eat. Senaur (1990) reports that in most American households' women not only remain the primary food purchaser but they also do approximately 90% of the family's cooking.

[1] Credence attributes do not allow a consumer to judge the quality of the product even after consumption.
[2] Search attributes provide full quality certainty given careful pre-purchase inspection assuming the cost of the search is negligible.

Scientific knowledge and public understanding of the linkages between diet and health has increased in recent years. During this time many researchers have tried to model and evaluate the determinants of consumer demand for food. Their findings and conclusions have not been uniform. Increased public awareness and concern about nutrition was thought to increase the demand for nutritionally superior products thus increasing the availability of such foods in both the at-home and away-from-home food markets (Canning et al., 2000; Lin and Frazao 1999; and Frazao and Allhouse, 1996). Yet other research (Mojduszka et al., 1999) concludes that the average nutritional quality of food products offered did not improve during this time period. Food industry analysts have highlighted sales failures among nutritionally improved food products (*The Food Marketing Institute Report,* 1999, 2000).

Determinants of Consumer Demand for Brands

This paper builds on and further extends existing work on the determinants of consumer demand for food products (Mojduszka et al., 2001) by expanding the understanding of the relationship between consumer's knowledge of nutrition and demand for nutrient quality.

The current literature is predominantly based on analysis at the aggregate product level data or at the disaggregate consumer level survey data. Relevant studies using data of this kind include Brown and Schrader (1990), Capps and Schmitz (1991), Gould and Lin (1994), Chern et al. (1995), Variyam et al. (1996), Adelaja et al. (1997), Chern and Zuo (1997), Kim and Chern (1999), and Chern (2000). Each of these studies have furthered the understanding of consumers knowledge and concern about nutrition and their food product choices; however, these studies are limited by methodology that employs only aggregate or disaggregate data sets. The methodology used in this paper utilizes both aggregate and disaggregate level data in order to overcome the limitations associated with working with data on either level alone.

To estimate our demand system for differentiated prepared frozen meals and salted snacks, a discrete choice model of individual consumer behavior is used (McFadden, 1978; Berry, 1994; Berry et al., 1995; Nevo, 1997; Shaked & Sutton, 1982; Perloff & Salop, 1985; Bresnahan, 1987). Estimated parameters of the demand system are then applied in order to assess the effectiveness of the mandatory labeling policies brought on by the NLEA legislation discussed in the first two sections of this paper.

Indirect utility functions are the backbone of discrete choice models. Here we assume that the level of utility that a consumer derives from a given product (brand) depends on the characteristics of both the product and the consumer. Thus, we can specify maximum utility derived by consumer *i* from consuming product *j* in time period *t* as:

$$u_{ijt} = \sum_k x_{jkt}\beta_{ik} + \xi_j + \Delta\xi_{jt} + \in_{ijt} \qquad (1)$$

where

$$\beta_{ik} = \overline{\beta}_k + \sum_r D_{irt}\beta_{kr}^{m} + \beta_k^{um} v_{ik} \qquad (2)$$

The differentiated products in the market are indexed as $j = 0, 1, \ldots, J$. If the consumer does not purchase any of the J brands and allocates their income to other purchases the outside good is represented as product $j=0$, so that u_{io} is the utility the consumer derives.[3] The x_{jkt} 's represents observed product characteristics, including price. The ξ_j is the national mean of the unobserved product characteristics and the $\Delta\xi_{jt}$ is a deviation from this mean specifically

[3] Based on equation (1), consumer utility derived from the outside good can be specified as: $u_{i0t} = \xi_0 + \pi_0 D_i + \sigma_0 v_{i0} + \varepsilon_{i0t}$, where π_0 and σ_0 are the coefficients on measured and unmeasured consumer characteristics.

calculated for each quarter. Lastly, the ϵ_{ijt} 's represent error terms in individual preferences and we assume these terms are independent of the product attributes and of one another.

In equation (2), β_{ik} represents the preference parameters of consumer *i* for product characteristic *k*. The D_{irt} represent measured consumer characteristics, where *r* is a consumer characteristic, including knowledge about nutrition and use of nutrition labels, and v_{ik} 's are unmeasured consumer characteristics. Thus, the β_{ik} 's are made up of two elements, the first captures the average consumer's preferences for an attribute and the second represents the deviation of individuals from the average preference based on their own characteristics. More over, the second element is made up of deviations based on both measured (*m)* and unmeasured (*um)* consumer characteristics.

The consumer level choice model is obtained by substituting equation (2) into equation (1) to yield:

$$u_{ijt} = \delta_{jt} + \mu_{ijt}, \text{ for } j = 0,\ldots,J, \tag{3}$$

where

$$\delta_{jt} = \sum_{k} x_{jkt} \overline{\beta}_k + \xi_j + \Delta\xi_{jt}, \tag{4}$$

and

$$\mu_{ijt} = \sum_{kr} x_{jkt} D_{irt} \beta_{kr}^{m} + \sum_{k} x_{jkt} v_{ik} \beta_{k}^{um} + \varepsilon_{ijt}\,. \tag{5}$$

The indirect utility of consumer *i* from product *j* in time period *t* is now expressed as the mean utility, signified by δ_{jt}, and the mean zero heteroscedastic deviation from that mean, μ_{ijt}, that captures the effects of the random coefficients, which reflect individual consumer characteristics or consumer heterogeneity. In this case, the contribution of x_k units of the *k*-th product characteristic to the utility of consumer *i* is given by:

$$(\overline{\beta}_k + \beta_{kr}^m D_{irt} + \beta_k^{um} \nu_{ik}) \chi_{jkt} \quad (6)$$

and varies across consumers. The mean of the utility from good *j*, δ_{jt}, is totally determined by the product characteristics and therefore represents a product specific component that does not vary with consumer characteristics. However, a deviation from that mean, μ_{ijt}, is dependent on the interaction between consumer and product specific characteristics. For example, consumers who have a preference for fat are likely to attach high satisfaction or utility to all fatty products, and this will create large substitution effects between fatty products.

The parameters of the model are $\theta=(\delta, \beta^m, \beta^{um})$. The vector δ includes the linear parameters and the vectors β^m and β^{um} contain the nonlinear parameters. Thus, in our methodology, consumer preferences vary as a function of individual characteristics. This simply amounts to models of the distribution of the consumer taste parameters.

The aggregate demand system is acquired by summing the choices implied by the individual utility model over the distribution of consumer characteristics in the population. We refer to the vector of measured and unmeasured individual characteristics by *w*, therefore,

$$w = (D, v, \varepsilon) \quad (7)$$

and we denote its distribution in the population by *Pw*.

All consumers choose the single unit of the good that maximizes his or her utility. With this in mind, aggregate demand for good *j* is given by the integral of the density of consumer characteristics over the set of characteristics that imply a preference for good *j*:

$$s_{jt}(\delta, \beta^m \beta^{um}, x) = \int_{A_{jt}} dP_w(w) = \int_{A_{jt}} dP_\varepsilon(\varepsilon) x dP_D(D) x dP_v(v) \quad (8)$$

where

$$A_{jt}(\delta, \beta^{m}, \beta^{um}; X) = \{w : \max_{r=0,1,\ldots,J}[u_{irt}(w; \delta, \beta^{m}, \beta^{um}, x)] = u_{irt}\} \tag{9}$$

Since each individual is described by a vector of demographics and product specific shocks, w=(D,υ,ε), the set A_{jt} describes individuals who choose brand *j* in time period *t*. Or in other words, the set represents individual characteristics that lead to choice of good *j*. The market share equation multiplied by the number of consumers in the market, *M*, creates the *J*-vector of demands as *M* X $s(\delta, \beta^{m}, \beta^{um}, x)$. Consumer heterogeneity is modeled as a function of the empirical non-parametric distribution of consumer characteristics without imposing any arbitrary functional forms on this distribution. Therefore, given the assumptions on the distribution of the unobserved variables (v and ε), we can compute the integral in the market share equation analytically or numerically.

The key benefit of using the random coefficients discrete choice model for estimating plausible demand elasticities is that in these models purchases are determined by the maximum utility for each individual consumer and not the mean utility for the aggregate consumer. For example, the market share of products rich in fat could be higher for two reasons: a high mean of the distribution of preferences for fat or a large variance of the same distribution. More over, the classic logit and random coefficients models have varying implications for substitution patterns. The classic logit model explains differences in market shares by allowing only the mean of consumer utility to change. Therefore, if the price of a fatty frozen entree or salted snack increases, the consumers who substitute away from that product have the same marginal utility of fat as any other consumer. The random coefficients model allows divergent market shares to also be explained by a distribution of consumer characteristics. Thus, consumers who substitute away from a fatty product have higher than average preference for fat and are more likely to substitute to other fatty product.

The random coefficients specification of the discrete choice enables more realistic substitution patterns. On the other hand, it reintroduces the dilemma of calculating the integral in the market share equation. This computational problem is solved in this paper by applying a simulation technique introduced by Pakes (1986).

Data and Variables

The models introduced in the previous section require data for a host of variables including specific product characteristics of prepared frozen meals and salted snacks, advertising and promotional expenditures and the distribution of consumer characteristics. Data was pulled from more than four sources to meet the demanding data needs for this project.

The IRI[4] Infoscan Database provided data on market shares, prices, and in-store marketing efforts for prepared frozen meal and salted snack products. This data was obtained with the assistance of the Food Markets Branch of the Economic Research Service, U.S. Department of Agriculture. The IRI Infoscan data is collected continuously by the scanning devices in a random, national sample of supermarkets located in 64 metropolitan and rural areas of the United States. The results presented are computed for the 300 prepared frozen meal and salted snack products with the highest volume sales in each quarter from 1995 to 1999.

The IRI data includes information on in-store marketing efforts. We use the percent of dollar value of all prepared frozen meals and salted snacks that were sold with price reductions, in-store displays, and in-store features to evaluate the impact of these efforts on consumer choice of prepared frozen meal and salted snack products.

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[4] Information Resources Inc., more commonly known as IRI, is a private firm that specializes in gathering market information and performing analytical services.

To account for the advertising and promotional influence on consumer choice outside of the food store, data from the Leading National Advertising database for 1995 to 1999 was utilized. These data have been collected quarterly for eleven types of mass media (e.g. network television, spot television, cable networks, national spot radio, network radio, newspapers, and magazines) for top brands (not at the product level). We used the total advertising expenditures on all of the eleven types of mass media for each brand (see Tables 1 and 2).

TABLE 1. Market Shares, Prices, Advertising, and Promotion of Products in Sample-Prepared Frozen Meals

Variable	Mean	Standard Deviation	Min	Max
Prices ($ per serving)	2.24	1.54	0.17	5.82
Share within Frozen Prepared Meals Market (%)	0.333	0.303	0.001	0.832
Price Reduction (% $)	14.07	8.62	0.00	95.13
Display (%, $)	3.61	5.47	0.00	100.00
Feature (%, $)	12.59	10.92	0.00	100.00
Advertising (Million $)	0.04	0.12	0.00	3.11

TABLE 2. Market Shares, Prices, Advertising, and Promotion of Products in Sample-Salted Snacks

Variable	Mean	Standard Deviation	Min	Max
Prices ($ per serving)	2.12	0.88	0.24	6.69
Share within Frozen Prepared Meals Market (%)	0.33	0.758	0.003	0.105
Price Reduction (% $)	9.10	6.79	0.00	45.50
Display (%, $)	20.00	13.05	0.00	74.50
Feature (%, $)	6.30	5.21	0.00	36.20
Advertising (Million $)	0.76	0.133	0.00	16.82

Due to the fact that IRI's Infoscan data does not include any nutritional information specific nutritional content values were gathered from both the Nutritional Labeling Data developed at the University of Massachusetts and United States Department of Agriculture's

Nutritional Database for Standard Reference. The Nutritional Labeling Data include a complete census of all products in the most popular package size offered in 33 food product categories in a representative super-store in New England for the years 1995 to 1999. The USDA's Nutritional Database for Standard Reference contains current nutritional content information at the product level. While these data sets provide information on many frozen meal and salted snack products, they do not contain information on all the products offered at the national level.[5] The discrete choice model introduced in the previous section included the following variables of nutrient content: calories, fat, cholesterol, sodium, fiber, protein, vitamin A, vitamin C and calcium. The levels of nutrient content variables for each product in the data set are based on standardized serving sizes that correspond to the reference amounts consumed on average by an adult person, as defined under the NLEA. Tables 3 and 4 provide the summary statistics for the attributes for the sample of 300 products of prepared frozen meals and salted snacks used in this analysis.

TABLE 3. Summary of Matched Scanner Data to Nutritional Labeling Data-Prepared Frozen Meals

	# of Observations Matched to Nutritional Labeling Data / # of Total Observations per Quarter				
	1995	1996	1997	1998	1999
Frozen Dinners	158 / 212	171 / 213	166 / 204	166 / 204	178 / 214
Frozen Entrees	79 / 88	70 / 87	79 / 96	83 / 96	77 / 86
TOTAL	237 / 300	241 / 300	245 / 300	249 / 300	255 / 300

[5] The Nutritional Labeling Data from the University of Massachusetts contains product information from a large super-store representative of regional product offerings in New England. The USDA's Nutritional Database for Standard Reference only offers product-specific information for a handful of popular products sold nationally in each product category.

TABLE 4. Summary of Matched Scanner Data to Nutritional Labeling Data-Salted Snacks

	# of Observations Matched to Nutritional Labeling Data / # of Total Observations per Quarter				
	1995	1996	1997	1998	1999
Potato Chips	35 / 63	41 / 57	32 / 57	40 / 57	32 / 58
Crackers	782/ 119	73 / 117	74 / 120	70 / 110	76 / 107
TOTAL	180 / 300	196 / 300	197 / 300	200 / 300	203 / 300

Tables 5 and 6 illustrate the summary statistics of the nutritional quality of our samples. Figures for each observation include all the components listed on the nutrition profile titled "Nutrition Facts" found on the packaging of all packaged foods since the implementation of the NLEA legislation in the mid-1990's.

TABLE 5. Summary of Statistics on Characteristics of Products in Sample- Prepared Frozen Meals

Variable	Mean	Standard Deviation	Min	Max
Calories	370.17	64.06	20.00	782.00
Fat (g)	12.47	5.03	1.00	54.00
Saturated fat (g)	6.24	8.58	0.00	80.00
Cholesterol (mg)	65.33	113.37	0.00	1120.00
Sodium (mg)	893.99	386.921	1.00	2195.00
Dietary fiber (g)	5.50	3.06	0.00	20.00
Protein (g)	16.67	3.72	1.00	45.00
Vitamin A (%)	23.58	21.52	0.00	212.00
Vitamin C (%)	14.58	10.91	0.00	68.00
Calcium (%)	9.02	6.86	0.00	60.00
Package Size (oz.)	13.84	6.80	6.00	48.00

TABLE 6. Summary of Statistics on Characteristics of Products in Sample- Salted Snacks

Variable	Mean	Standard Deviation	Min	Max
Calories	133.56	31.10	31.00	420.00
Fat (g)	6.47	3.28	0.00	12.00
Saturated fat (g)	1.46	1.05	0.00	8.00
Cholesterol (mg)	0.12	1.00	0.00	5.00
Sodium (mg)	192.50	85.63	0.00	680.00
Dietary fiber (g)	0.74	0.94	0.00	11.77

Protein (g)	2.16	0.93	1.00	14.58
Vitamin A (%)	0.08	0.50	0.00	10.00
Vitamin C (%)	2.55	0.50	0.00	22.00
Calcium (%)	1.16	1.30	0.00	4.00
Package Size (oz.)	11.65	4.15	1.00	32.00

Next, we obtained information on the distribution of consumer knowledge about nutrition and nutrition label use by sampling individuals from the Diet and Health Knowledge Survey (DHKS) carried out by the U.S. Department of Agriculture. The DHKS surveys 1,966 individuals, 20 years of age or older, who are the main meal planners in their households. The survey includes questions concerning the consumer's attitudes toward and knowledge of nutrition, food safety, and diet and health, as well as their use of nutrition labels. We use the questions from the DHKS that relate to knowledge about nutrition related to fat and to nutrition panel use in our analysis. Our hypothesis is that these factors play a significant role in consumer food choices. Nutrition panel use can allow consumers to precisely evaluate the nutritional quality of foods they choose. As introduced earlier, all packaged foods have been required to carry nutrition panels since May 1994. We are able to estimate how consumer knowledge of nutrition and use of nutrition panels affect consumer choices of products in the selected food categories over time by incorporating this information into out empirical analysis.

Lastly, we obtained statistical information on the distribution of consumer demographic variables by sampling individuals from the Current Population Survey (CPS) conducted each year by the U.S. Bureau of the Census. Consumer per capita income was constructed by dividing household income by the size of the household. Other important economic and demographic variables like income, education, age, percentage of elderly people, and percentage of women working were included. The CPS data are representative of the national population statistics from the Bureau of the Census.

Table 7 reports the sample statistics on consumer knowledge about fat, consumer use of nutrition panels, and consumer demographics.

TABLE 7. Fat Knowledge, Nutrition Panel Use, and Demographic Variables

Variable	Mean	Standard Deviation	Min	Max
General Fat Knowledge	0.75	0.65	0	1
Specific Fat Knowledge	0.61	0.53	0	1
Nutrition Panel Use	0.76	0.80	0	1
Income ($)	26,698	12,362	0	190,000
Household Size	2.79	1.75	1	11
Age	32	29	22	89

The Creation of the Integrated Data Set

This unique integrated data set was created by hand using several matching criteria. IRI categorizes both prepared frozen dinners and prepared frozen entrees into the same category of prepared meals as well as potato chips, tortilla chips, crackers, pretzels, popcorn, cheese snacks, breadsticks, and other salted snacks into the same category of salted snacks. In order to investigate potential differences in consumer determinants for each of these product groups we separated them and created a new variable to distinct one group from the other. After organizing the IRI scanner data into yearly quarters, each quarter was sorted by volume sales and the highest ranking three hundred observations were selected for study.

Since the NLA data is not product specific but rather brand specific, all products were sorted by brand. Brand level advertising expenditures were divided by the number of observations for each brand within the sample, for each quarter, and each individual product was assigned the newly calculated advertising expenditure.

Finally, nutritional data was matched to specific products for all quarters in each year. Both nutritional content data sets, The Nutritional Quality Change Data and the National Nutrient Database, were used to find as many exact product matches as possible. Neither nutrient content data set contains information on all the products offered at a national level. As a result, some products included in the scanner data are missing in the nutritional data. When nutrient content information was not available for specific products, average nutrient content values for the missing product was assigned based on similar products. Because the Nutritional Quality Change Data was not collected in 1996 and 1998, 1997 nutritional data was used in 1996 and 1999 data was used for 1998. Substituting data for these missing years is acceptable because Mojduszka et al (1999) found that nutritional profiles were changing slowly during this time frame.

The Estimation Algorithm

Random coefficient discrete choice specification of aggregate demand is a complex function that includes both linear and non-linear parameters. The root of the complexity lies within discrete choice set for each individual and the interaction between individual and product characteristics. Also, observed and unobserved product attributes are distinguished from each other. The unobserved product attributes reflect the difficulty in quantifying not only consumer taste and previous experience but also reputations of individual firms. Obviously, if these unobserved characteristics are significant factors in consumer choices of frozen meals and salted snacks, prices will be correlated with them. Needless to say, the price elasticity estimates would be biased then.

We can control for unobserved attributes by using our product level data to develop brand specific dummies and plugging them into the demand equation. These brand specific dummies measure consumer mean utility. They also include the linear utility components of product characteristics. The characteristics that do not vary with individual consumer tastes are captured by the dummies and, thus, can be considered as fixed brand effects. More so, we can account for the correlation between the unobserved quality and prices by including these brand specific dummies. At this point, the error term is no longer the unobserved quality but it is a quarter specific deviation, $\Delta\xi_{jt}$, from this unobserved national mean. The orthogonality between $\Delta\xi_{jt}$ and the x-vector cannot be used for estimation if the observed characteristics are not transformed into a linear function of $\Delta\xi_{jt}$. Berry (1994) introduced a method of transformation that accomplishes this.

This paper employs Berry's method, which relies on a formation of a Generalized Method of Moments (GMM) estimator. The procedure requires that the implied error term be computed for a given value of the unknown parameters and then interacting the error term with instruments thus forming the GMM objective function. Berry's method calculates the implied error term by inverting the market share function to obtain the vector of mean utilities that equates the observed market shares to the predicted market shares. This is done by solving the implicit system of equations for each market

$$s_t(\delta_t;\theta_2) = S_t \qquad (12)$$

The error term is defined as the following once this inversion is performed

$$w_{jt} = \delta_{jt}(s_t;\theta_2) - (x_j\beta + \alpha p_{jt}) \qquad (13)$$

This equation only utilizes the observed market shares. We calculate the mean utility, δ_{jt}, for a given value of the nonlinear parameters, θ_2, that would make the predicted market share equal to the observed market share. The residual is then defined as the difference between this mean utility and the one predicted by the linear parameters, α and β. The GMM estimator is defined as

$$\hat{\theta} = \arg\min_{\theta} w(\theta)' Z A^{-1} Z' w(\theta) \qquad (14)$$

and minimizes the distance between these different predictions.

The estimation method utilized can be summed up in the following steps. To begin, we compute the market shares, for a given value of θ_2 and δ, implied by equation (8). Next, for a given value of θ_2 we compute the δ vector that equates the market shares obtained in the previous step to the observed shares. Then, we compute the error term, for a given value of θ, to interact it with instruments. At this point, the value of the GMM objective function can be obtained. Lastly, we search for the value of θ that minimizes the objective function from the previous step. We performed all the estimations and calculations by utilizing the Matlab computer program (see also Nevo, 1998).

Estimation Results and Discussion

This section explains our rationale for utilizing a random coefficient model and presents the results for the random specifications of the discrete choice model of consumer demand for prepared frozen meals and salted snacks. In order to estimate the model, data for the 300 products with the highest volume sales in each food product category, in all quarters from 1995 to 1999 was used. The market share of these products varies from 0.0015% to 0.8316% of the total national sales of prepared frozen meals and salted snacks in each of the twenty quarters studied.

The estimated parameters of the random coefficients model are presented for the 6,000 observations (300 products in 20 quarters, 1995-1999) and can be viewed in Tables 8 and 9 (located on page 23 through page 27). They are derived from the utility function specified by equation (3). The marginal utility derived from each attribute varies across consumers so that we estimate a mean and a variance for each of the attributes, unlike in a logistic discrete choice model. However, the dependent variable is the market share of a particular product relative to the total market size (including the alternatives and the outside good) as it would be in a logit model.

The estimates of the means and standard deviations of the marginal utility distributions for each attribute are presented in the first two rows of Tables 8 and 9. The mean coefficients on product characteristics are retrieved by a minimum distance regression of the GMM product specific dummy coefficients on product characteristics (Chamberlain, 1982). The following five rows present the estimated parameters that measure interactions between consumer and product characteristics. The means of the distribution of marginal utilities, β, are all statistically significant at the five percent level except for in-store display and featuring which are significant at the ten percent level and package size which is insignificant.

The results indicate that both calories and fat have a positive effect on marginal utility for the average consumer. However, sodium has a negative effect on marginal utility for the average consumer. These findings, specifically related to calories and fat, can be attributed to strong consumer preferences for taste rather than their concerns about nutrition and health.

The next six rows illustrate the estimates of standard deviations of marginal utilities, σ, most of which are statistically significant (with the exception of calories and package size). The coefficients of these variables capture the deviation from the mean of average consumer that is not already captured by consumer characteristic variables.

The results signify that all of the interactions with the demographic variables are significant (at the five percent level). These results lead us to believe that heterogeneity in the coefficients is mostly explained by the included demographic variables, most importantly income. Marginal utility from sodium decreases as income increases.

The mean price coefficient is negative; as one might expect this indicates that the average consumer’s utility decreases as price increases. Coefficients on the interactions of price with demographics are all statistically significant. Consumers with income that is classified as above average have a tendency to be less price sensitive much like smaller households.

Again, looking back at the top of the table, the mean coefficients on advertising, price reduction, in-store display, and featuring are positive. More so, advertising and price reduction have a significant effect on consumer valuation of frozen meals and salted snacks at the five percent level, yet in-store display and featuring do not (they are only significant at the ten percent level). The lack of significance exhibited by many coefficients on the latter variables may have something to do with a higher correlation between the price reduction and display and featuring variables.

The utility a consumer derives from the outside good is explained by the constant term. Consumers with higher than average income and households of larger size are less likely to buy prepared frozen meals and salted snacks and put a higher value on the outside option.

Most of the estimated coefficients on both fat knowledge variables and on the nutrition panel use variable are negative but statistically insignificant with the exception of calories which is significant. Thus, knowledge about fat, whether in general or specific form, and nutrition panel use, have no significant effect on how consumers choose prepared frozen meals and salted snacks. It should be noted that the constant is significant when interacting with both general and specific fat knowledge.

The interaction of the fat knowledge variables with the product characteristic variables was also tested; none of the interaction variables were statistically significant. These results present further confirmation that knowledge about fat and nutrition panel use, at least they way they are specified here, have no significant impact on consumer choices. In the future, we plan to explore alternative specifications of the nutrition knowledge variables. For example, Variyam et al. (1996) found that nutrition knowledge was not a significant factor for dietary fiber intake but that nutrition awareness and attitude towards nutrition was significant.

Summary and Conclusions

This research provides new methods to analyze the effects of the many factors that determine consumer food choice including government information policy, firms' marketing strategies, consumer's tastes, nutrition knowledge and attitudes, education, and income. Over the past decades, increased scientific understanding of the diet – health link has been publicized by the media. The government responded by placing strict regulations on food labeling in order to give consumers the adequate tools to make good food consumption decisions. However, more Americans than ever before are or at great risk of becoming overweight or obese. Diet related health problems are responsible for much of our nation's mortality and a large portion of our nation's health care costs. Why are consumers making poor food choices in light of the information available to them? The comprehensive assessment of the determinants of consumer food choices presented here will serve to inform ongoing policy debates relating to nutrition, income, advertising, consumer knowledge, and government regulation of information.

The methodology employed by this research enables an in-depth analysis of the current determinants of consumer food choices. Not only can conclusions be drawn about the strength of specific determinants of consumer food choice but we can also evaluate how these determinants have changed in strength overtime. The goal of this research was to explain the paradox introduced above and find why increased public nutrition information has not translated into improved dietary choices. Clearly, several factors work together simultaneously to influence demand at any given time.

The model employed in this paper is defined in terms of a utility function that allocates values to different possible combinations of product characteristics as a function of consumer characteristics. Own- and cross-price elasticities as well as elasticities of demand with respect to product attributes can be calculated for all of the products considered. The results have potentially important implications for analysis of the effectiveness of government regulation of nutrition labeling of processed foods.

The estimates derived here of consumer preference parameters for the nutritional attributes of prepared frozen meals and salted snacks indicate that consumers do not value many nutritional characteristics of frozen meal products. Both calories and fat are valued positively but sodium is valued negatively. Our findings with regard to the positive valuation of calories and fat can be linked to strong consumer preferences for taste rather than nutrition and health-related attributes. The computed results confirm that product prices and advertising play a much larger part in consumer choices of prepared frozen meals than do nutritional characteristics. Consumer knowledge about fat and nutrition panel use do not seem to have a significant impact on consumer food choices.

The mandatory labeling policy was put into practice in order to give consumers a means to learn more about the nutritional quality of the foods they eat. The labeling policy was intended to support consumers in their food choices specifically in the hope that it would yield greater demand for foods with better nutritional profiles. Unfortunately, our results indicated that the mandatory nutritional labeling policy has been ineffective in influencing consumer demand for prepared frozen meals and salted snacks through the late 1990's. A great financial investment, both public and private, was made in putting this labeling legislation into practice. Due to the fact that little of the rule's intended food choice changes has been realized, as indicated by our results, the outlay already made in nutrition labeling might generate a larger payoff with a more active educational campaign.

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TABLE 8. Estimates of the Random Coefficients Discrete Choice Model, Prepared Frozen Meals, 1995-1999

Component	Variable	Estimate	t-Statistics
Means (β's)	Price	-12.856 **	-3.8690
	Advertising	0.0852 **	3.6480
	Price Reduction	0.2077 **	2.8663
	Display	0.2860 *	1.5011
	Feature	0.0276 *	1.3261
	Constant	-3.160 **	-1.9982
	Calories	0.320 **	4.2855
	Fat	0.0130 **	4.3655
	Sodium	-0.0601 **	-4.3277
	Package Size	-0.0030	-0.4542
Standard Deviations (σ's)	Price	0.0980 *	1.3877
	Constant	0.0370 *	1.3864
	Calories	0.0010	1.2411
	Fat	0.0010 *	1.2897
	Sodium	0.0050 *	1.4633
	Package Size	0.0020	0.7684
Interaction with Income	Price	13.1700 **	3.6477
	Constant	-0.6210 **	-3.2325
	Calories	0.0253 **	2.1430
	Fat	0.0020 **	1.7422
	Sodium	-0.0240 **	-1.7582
Interaction with $Income^2$	Price	-10.2655 **	-5.9140
Interaction with Household Size	Price	-17.8223 **	-2.5112
	Constant	-0.1460 **	-2.8227
	Calories	0.0020 **	1.8590
	Fat	0.0250 **	1.8699
	Sodium	-0.0130 **	-1.7647

This table is continued on the next page.

TABLE 8. Estimates of the Random Coefficients Discrete Choice Model, Prepared Frozen Meals, 1995-1999, (Continued)

Component	Variable	Estimate	t-Statistics
Interaction with Specific Fat Knowledge	Price	0.2003	0.7562
	Constant	-0.0190 *	-1.4430
	Calories	-0.0030	-1.1090
	Fat	-0.0012	-0.7322
	Sodium	-0.0060	-0.6433
Interaction with Nutrition Panel Use	Price	-0.2082	-0.5377
	Constant	-0.0210	-1.1466
	Calories	-0.0010	-0.2300
	Fat	-0.0011	-0.3157
	Sodium	-0.0052	-0.5376
GMM Objective Function		10.115	
Minimum Distance χ^2		2447	
% of Price Coefficients >0		50	

Dependant variable is $\ln(S_{jt}) - \ln(S_{0t})$.
** significant at the 5% level.
* significant at the 10% level.
All regressions include time dummy variables that are statistically insignificant.

TABLE 9. Estimates of the Random Coefficients Discrete Choice Model, Salted Snacks, 1995-1999

Component	Variable	Estimate	t-Statistics
Means (β's)	Price	-6.023 **	-3.3522
	Advertising	0.1046 **	3.8743
	Price Reduction	0.1862 **	3.0440
	Display	0.2750 *	1.4010
	Feature	0.0950* *	2.1303
	Constant	-4.0535 **	-2.1004
	Calories	0.0401 **	4.0462
	Fat	0.0204 **	3.7410
	Sodium	-0.0472 **	-2.0253
	Package Size	-0.0027	-0.0319
Standard Deviations (σ's)	Price	0.0746 *	1.3920
	Constant	0.0271 *	1.4262
	Calories	0.0017	1.2021
	Fat	0.0012	1.0310
	Sodium	0.0010	1.0411
	Package Size	0.0019	0.4964
Interaction with Income	Price	5.8407 **	3.4211
	Constant	-0.5866 **	-3.1024
	Calories	-0.0310 **	-2.7952
	Fat	0.0036 **	1.6482
	Sodium	-0.0410**	-1.8492
Interaction with $Income^2$	Price	-4.8230 **	-3.8584
Interaction with Household Size	Price	-6.1753 **	-2.7363
	Constant	-0.1330 **	-2.6301
	Calories	0.0104**	1.9361
	Fat	0.0383 **	1.9475
	Sodium	-0.0157 **	-1.8374

This table is continued on the next page.

TABLE 9. Estimates of the Random Coefficients Discrete Choice Model, Salted Snacks, 1995-1999 (Continued)

Component	Variable	Estimate	t-Statistics
Interaction with Specific Fat Knowledge	Price	-0.2003*	-1.3622
	Constant	-0.1523* *	-1.9931
	Calories	-0.0285*	-1.3992
	Fat	-0.0317	-1.2382
	Sodium	-0.0361	-1.0315
Interaction with Nutrition Panel Use	Price	-0.0740	-0.9225
	Constant	-0.0153	-1.2100
	Calories	-0.0026	-0.4835
	Fat	-0.0073	-0.2691
	Sodium	-0.0063	-0.8520
GMM Objective Function		8.632	
Minimum Distance χ^2		2285	
% of Price Coefficients >0		29	

Dependant variable is $\ln(S_{jt})$ - $\ln(S_{0t})$.
** significant at the 5% level.
* significant at the 10% level.
All regressions include time dummy variables that are statistically insignificant.