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Endogenous Consumer Preferences And Knowledge About Nutrition

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Introduction

The 1990s presented a striking paradox for consumer food choice in the United States. Awareness of the health impacts of diet increased in the U.S. population, while the implementation of mandatory nutritional labeling in 1994 made it easier for consumers to obtain information on the content of food products. However, several measures of health outcomes for the 1990s suggest that nutritional concerns are frequently not paramount in consumer food choices. Many Americans, adults and children, have poor diets and are becoming overweight at far greater numbers than ever before. According to the American Heart Association, the levels of obesity in the United States increased from 25 percent in 1976-1980 to 33 percent in 1988-1991. In the late 1990s, one in two American adults and one in four American children were overweight or obese (The Centers for Disease Control and Prevention web site—news). The effects are not only cosmetic; the problems of nutrition and obesity foster many deadly ills, from hypertension and heart disease to diabetes and cancer. The estimated cost of this epidemic to the general public health budget by 2020 is estimated to be in the hundreds of billions of dollars (The Centers for Disease Control and Prevention web site—news).

Thus nutritional concerns do not appear to have been strongly influencing consumer demand. What are the important determinants of consumer demand and how have they been changing over the last decade? Understanding these factors is crucial for evaluating the benefits and costs of government regulations, such as labeling, intended to influence consumer food choice and, ultimately, public health; for assessing the competitiveness of U.S. agricultural producers and food processors as they choose product designs and marketing strategies; and for assessing the impact of changing consumer demand for food on the agricultural and food sectors of the U.S. economy.

The objectives of this paper are to make a significant contribution to demand analysis by basing this understanding on the use of uniquely comprehensive data sets and

theoretical/modeling techniques that evaluate demand on the brand level; and to build a comprehensive understanding of the relative importance of different determinants of consumer food choices in the decade from 1993-2002. The overall goal is to analyze what is driving consumer choices and the implications of these drivers for food and nutrition policy in the United States. A particular focus is the relative importance of advertising, other company marketing strategies, nutritional quality, privately and publicly provided nutritional information, and consumer dietary concerns and knowledge in determining consumer demand for food products.

Supporting Research

Significant effort has gone into tracking and evaluating the determinants of consumer demand for food over recent years. In these years, new information about the linkages between diet and health and the communication of this information to the general population through private and public campaigns has led to increased awareness of diet-health linkages. This is thought to have led to an increase in the demand for foods of higher nutritional quality and in the availability of such foods in the at-home and away-from-home food markets (Canning et al. 2000, Lin and Frazao 1999, Frazao and Allshouse 1996). However, other evidence (Mojduszka et al. 1999) suggests that the average nutritional quality of foods offered for sale did not improve during this period. The business press has recently been highlighting sales failures among nutritionally improved food products (*The Food Marketing Institute Report* 1999, 2000).

In this paper, we build on and extend already completed work on the determinants of consumer demand for brands within one category of food products, frozen entrees (Mojduszka, Caswell, and Harris 2001). Our research approach moves beyond existing work on the determinants of food choices and the impact of information provision, particularly work on the relationship between nutrition information and demand for foods or nutrient intakes. The current literature is primarily based on analysis of aggregate product level data or disaggregate consumer level survey data. Examples of these studies include Brown and Schrader (1990), Capps and Schmitz (1991), Gould and Lin (1994), Chern et al. (1995), Variyam, Blaylock, and Smallwood (1996), Chern and Zuo (1997), Kim and Chern (1999), and Chern (2000). These studies advanced

our knowledge of the relationship between information and consumer food choices but are limited by their focus on limited aggregate or disaggregate data sets.

The aggregate analysis approach uses total national sales data for particular commodities and incorporates consumer health knowledge/concerns into Lancasterian commodity demand models via indexes of information. These indexes quantify consumer health knowledge/concerns and their impacts on consumption patterns. Brown and Schrader (1990) and Chern et al. (1995), for example, explore the effects of information by analyzing aggregate national consumption and price data for cholesterol and the fats and oils to determine the impact of increased information on demand. Using their index of cholesterol information, Brown and Schrader show that an increase in information about cholesterol decreased per capita egg consumption. Chern et al. apply the Brown and Schrader index in a study of the consumption of fats and oil. The authors show that an increase in cholesterol information reduced consumption of butter and lard, but not necessarily of all fats and oil. The advantage of this approach is that it evaluates the impacts of health concerns on actual consumer behavior based on observed consumption data. However, it has major disadvantages for purposes of understanding the determinants of consumer food choices. Chief among them is that analysis based on aggregate product level data does not allow precise estimates of the distribution of consumer utilities. This approach does not allow us to link individual consumer characteristics to product characteristics and does not allow us to obtain preference parameters for each consumer as well as demand elasticities with regard to product characteristics for each product considered.

On the other hand, analysis based on disaggregate consumer-level survey data (e.g., the Continuing Survey of Food Intakes by Individuals (CSFII) and the Diet and Health Knowledge Survey (DHKS)) has the advantage of being very useful in handling the unobserved variables of consumption perception and consumer valuation of non-market goods. However, there has been skepticism about the correlation between the knowledge/concerns stated in the survey and actual consumption behavior. For example, Variyam et al. (1996) use the CSFII and DHKS to examine the relationship between income, knowledge about diet/health relationships, and the nutrient intake of individuals who plan household meals. The study finds that although higher income was

associated with greater knowledge about the fiber content of foods, as people's incomes increased, they reduced fiber consumption, despite its health benefits. While Variyam et al.'s approach raises interesting and important questions about the relationship between nutrition information and the income effect, their approach cannot yield a comprehensive analysis of the determinants of consumer demand because the consumer-level surveys do not provide information on several important market variables (e.g., prices, advertising, brand strategies) that also influence consumer food choices.

The decade of the 1990s is particularly interesting for analysis of the determinants of consumer food choices because mandatory nutrition labeling was implemented in 1994 under the Nutrition Labeling and Education Act of 1991 (NLEA). The benefits estimated in the regulatory impact analysis for NLEA by the U.S. Food and Drug Administration were based on a forecasted impact of increased consumer information, improved consumer food choices, and ultimately, decreases in chronic disease rates in the United States (*Federal Register* 1991, Zarkin et al. 1991). There have been relatively few empirical studies of the actual effects of mandatory nutrition labeling and only one effectively controls for other important determinants of consumer demand. Existing studies use aggregate or disaggregate data in their analyses.

Using aggregate data, Moorman (1998) investigates the impact of the availability of market information related to the NLEA on the nutritional quality of food product offerings, the nature of competitive rivalry among manufacturers, and consumer activism in using information. She finds that changes in information may confer benefits on the market but that these benefits might be limited in scope. More specifically, the results of her study show that no significant changes occurred in the nutritional quality of food product offerings despite increased consumer activism in using information. Mojduszka et al. (1999) examine nutritional quality change in product offerings in five selected food categories using brand-level data. They find that no significant changes occurred in the average nutritional quality of food products offered for sale by manufacturers after the implementation of the NLEA. In this sense, Mojduszka et al. (1999) confirm Moorman's finding that changes in information availability may have more limited market impacts than was previously theorized (Caswell and Padberg 1992, Moorman 1998).

Research using disaggregate consumer-level data offers complementary results. For example, Finke (2000) investigates what contributes to good nutritional outcomes. He utilizes data from the CSFII and the DHKS to analyze the relationship between education and nutrient intake, finding a strong relationship between education level and fat intake. The major shortcoming with these approaches is their comparative static analysis. In other words, they do not expressly include and control all the important determinants of consumer food choice so that the impact of nutrition information (and knowledge) can be accurately assessed. This paper addresses this gap in the literature by developing a new methodology that can be used to evaluate whether there was a change in the relative importance of different determinants of food demand during the decade of 1993-2003.

The Methodology

Our paper expands and extends a line of research using discrete choice demand and latent variable models developed to address shortcomings in current approaches to analyzing the determinants of consumer food choices (see Mojduszka, Caswell, and Harris, 2001). This approach combines both aggregate store-level product data and disaggregate individual consumer-level survey data. It is based on important developments in the theoretical literature regarding approaches to analysis of consumer and producer behavior in differentiated product markets and on incorporating latent variables into modeling of consumer choice (Ben-Akiva et al., 2002). Our approach draws from and expands on discrete choice models developed by McFadden (1978), Berry (1994), and Berry et al. (1995 and 2000). These models provide an effective approach for the theoretical modeling and empirical estimation of consumer demand and producer supply parameters in differentiated product markets and are consistent with a structural model of equilibrium in oligopolistic industries. In these models, products are bundles of attributes and consumers have preferences defined on this attribute space. Consumer preferences are functions of product attributes (some of which are unobserved) and consumer characteristics. Each consumer chooses the product that maximizes his/her utility and interactions between product and consumer characteristics generate reasonable estimates of individual consumer preference parameters and cross-price and own-price elasticities at the product level. The most recent

literature in this area emphasizes gains from using alternative data sources (e.g., aggregate and disaggregate such as significant improvements in the precision of the estimated demand parameters. Increasing precision of the estimates by adding more data is a common strategy in econometrics. This strategy eliminates the need for often very restrictive theoretical and empirical assumptions (Berry et al. 2000).

Initial work by the authors of this paper uses the discrete choice approach to analyze the determinants of demand for frozen entrees (single serving entrees, family pack entrees, frozen dinners, and pizza) for the years 1993-1998 (Mojduszka, Caswell, and Harris, 2001). As has been the case in other theoretical and empirical work in this area, the models used assume that consumer preferences are exogenous. In other words, it assumes that these preferences are determined by forces outside the model and not determined within the model by endogenous influences. For example, the model assumes that consumers choose products based on their preferences, product characteristics, and other factors, with consumer preferences being given. Thus the nutrition knowledge level may attract consumers' attention to a particular nutritionally improved brand and increase their likelihood of buying it but does not alter the consumers' underlying preferences across different brands. Mojduszka et al. empirically tested the effect of a broad range of determinants on consumer demand for particular brands of frozen entrees. The determinants included nutrient content variables, prices, advertising, socio-demographic variables, nutrition knowledge and label use variables, and in-store marketing efforts. Results for this product category for the years covered show that prices, advertising, price reductions, and consumer preferences for taste have a significant effect on the demand for frozen entrees, whereas knowledge about nutrition and nutrition label use do not.

Modeling with Exogenous Consumer Preferences

Our paper focuses on developing a suitable methodology to empirically evaluate the determinants of consumer food choices over a decade of time from 1993-2002. To date, we have applied a model of this choice assuming exogenous consumer preferences to one product category, frozen entrees, for the years 1993-1998.

We first develop, specify, and estimate discrete choice demand models for the four selected food categories using the standard economic assumption that consumer preferences are exogenous. We analyze how consumer tastes, consumer characteristics (including knowledge of nutrition and nutrition label use), brand characteristics (including the nutritional content of foods), and manufacturers' marketing strategies (including advertising and brand strategies) influence individual food choices as measured by purchases of specific brands of food products. The time frame of the analysis from 1993-2002 allows evaluation of whether the determinants of demand for food products changed over this decade.

We obtain own- and cross-price elasticities as well as elasticities of demand with respect to brand-level nutritional characteristics for all brands. The discrete choice demand method is the only one suitable to this purpose because it allows us to link individual consumer demand for brands of food products to underlying characteristics of these brands. The resulting estimations allow us to evaluate the implications of the demand elasticities for government policy. For example, a positive, large magnitude elasticity of demand with respect to cholesterol would imply that consumers prefer products with higher cholesterol and that government efforts to educate consumers about health problems related to the consumption of high cholesterol foods have not been effective.

To obtain the demand system for heterogeneous consumers and products, we use a discrete choice model of individual consumer behavior with exogenous consumer preference formation (see McFadden, 1978; Berry, 1994; Berry et al. 1995; Nevo, 1997; as well as the literature on product differentiation by Shaked and Sutton, 1982; Perloff and Salop, 1985; Bresnahan, 1987). This demand system serves as a benchmark for the more sophisticated model we develop where consumer preferences are endogenous. We apply the estimated parameters of the demand system to evaluate the determinants of consumer food choices over time, including the role of publicly and privately provided information about nutrition and the role of food firms' marketing strategies.

Discrete choice models utilize indirect utility functions and assume that the level of utility that a consumer derives from a given product (brand) depends on both product characteristics and consumer characteristics. Therefore, we specify the maximum utility derived by consumer i from consuming product j in time period t as:

$$u_{ijt} = \sum_k x_{jkt}\beta_{ik} + \xi_j + \Delta\xi_{jt} + \varepsilon_{ijt}$$

where

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

The products competing in the market are indexed as j=0, 1,..., J. Product j=0 is the outside good, so that u_{i0} is the utility the consumer derives if she does not purchase any of the J brands and allocates her income to other purchases. The x_{jkt}'s are observed product characteristics, including price. The ξ_j is the national mean of the unobserved product characteristics and the $\Delta\xi_{jt}$ is a quarter specific deviation from this mean. The β_{ik}'s are the preference parameters of consumer i for product characteristic k. The D_{irt}'s are 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 from a multi-variate normal distribution. Therefore, the β_{ik}'s are made up of a first component that captures the average preferences (tastes) of all consumers for an attribute and a second component that represents the deviation of individuals from the average preference based on their own characteristics. This latter component is made up of deviations based on both measured (m) and unmeasured (um) consumer characteristics. Finally, the ε_{ijt}'s represent error terms in individual preferences. In this part of the paper we assume that the consumer knowledge of nutrition, nutrition panel use, and advertising are exogenous to our demand system.

We find the consumer level choice model by substituting the second equation into the first equation to obtain:

$$u_{ijt} = \delta_{jt} + \mu_{ijt}, \; for \; j = 0, 1, ..., J,$$

where

$$\delta_{jt} = \sum_{k} x_{jkt} \overline{\beta}_{k} + \xi_{j} + \Delta \xi_{jt},$$

and

$$\mu_{ijt} = \sum_{kr} x_{jkt} D_{irt} \beta^{m}_{kr} + \sum_{k} x_{jkt} v_{ik} \beta^{um}_{k} + \varepsilon_{ijt}.$$

The indirect utility of consumer i from product j in time period t is expressed as the mean utility, referred to as δ_{jt}'s, and the mean zero heteroscedastic deviation from that mean, μ_{ijt}, that captures the effects of the random coefficients, which reflect individual consumer characteristics. In this case, the contribution of x_k units of the k^{th} product characteristic to the utility of consumer i varies across consumers and is given by:

$$(\overline{\beta}_{k} + \beta^{m}_{kr} D_{irt} + \beta^{um}_{k} v_{ik}) x_{jkt}$$

The mean of the utility from good j, δ_{jt}, is entirely determined by the product characteristics and thus represents a product specific component that does not vary with consumer characteristics. On the other hand, a deviation from that mean, μ_{ijt}, depends on the interaction between consumer and product specific characteristics. As a result, consumers who have a preference for fat, for example, will tend to attach high utility to all fatty products, and this will induce 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 non-linear parameters.

We obtain the aggregate demand system by summing the choices implied by the individual utility model over the distribution of consumer characteristics in the population. We denote the vector of measured and unmeasured individual characteristics by w, therefore,

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

We denote its distribution in the population by P_w. Each consumer chooses one unit of the good that maximizes its utility therefore aggregate demand for good j is given by the integral of the density of consumer characteristics over the set of product characteristics that imply a preference for good j:

$$s_{jt}(\delta, \beta^m, \beta^{um}, x) = \int_{A_{jt}} P_w(dw) = \int_{A_{jt}} P_\varepsilon(d\varepsilon) * P_D(dD) * P_v(dv)$$

where

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

By multiplying the market share equation by the number of consumers in the market, M, we obtain the J-vector of demands as $M*s(\delta, \beta^m, \beta^{um}, x)$. We model consumer heterogeneity as a function of the empirical non-parametric distribution of consumer characteristics without imposing any arbitrary functional forms on this distribution. Thus, given the assumptions on the distribution of the unobserved variables (v and ε), we are able to compute the integral in the market share equation analytically or numerically.

We apply a simulation technique introduced by Pakes (1986) in order to estimate consistently a random coefficients discrete choice model of consumer demand for all of the brands in the selected food categories for the years 1993-2002.

Modeling with Endogenous Consumer Preferences

In this part of the paper we extend the model to make consumer preferences endogenous in two separate ways. Our work expands on previously used discrete choice models by treating

consumer preferences as endogenous, by assessing the effects of horizontal and vertical quality attributes more thoroughly, and by considering not only media advertising but also in-store marketing efforts. Doing so is important because preferences are likely endogenous (correlated with knowledge, advertising, and other marketing efforts) and treating them as exogenously given results in inaccurate estimates of the relative importance of various determinants of consumer food choices. Thus, this modeling and empirical analysis can make a significant contribution to the design of effective information programs and marketing strategies.

To address the problem of estimation, we build on our previously completed work on discrete choice modeling of consumer demand (Mojduszka et al., 2001). This work provides a model of individual consumer utility and demand that is explicitly aggregated to obtain product level demands. It therefore already contains a framework for analyzing aggregate and disaggregate data sources. However, consumer choice of food products may be further conditioned by nutrition information. To account for this possibility, we assume that consumer choice of food products and nutrition information are correlated, implying a simultaneous system of equations. We incorporate nutrition information measures in an integrated discrete choice model system of product choice and nutrition information (Ben-Akiva and Bowman, 1998; Ben-Akiva et al., 2002). In this new model, the distribution of consumer utilities depends on both measured and unmeasured individual characteristics. These determine preferences for product attributes (some of which are unobserved) and hence determine demand.

The proposed methodology integrates latent variables in the choice model and incorporates indicators of the latent variables provided by responses to survey questions to aid in estimating the model. A simultaneous estimation technique is used, which results in latent variables that provide the best fit to both the choice and the latent variable indicators. The integrated model framework consists of two main components, the choice model (described in the previous section) and the latent variable model.

For the latent variable model, we need the distribution of the latent variables given the observed variables

$$D^*_{irt} = h(X_{jkt}; \gamma) + \eta, \text{ for } j = 0, 1, ..$$

This gives us one equation for each latent variable. In addition, for the latent variable model we need the distribution of the indicators conditional on the values of the latent variables.

$$D_{irt} = g(D^*_{irt}, X_{jkt}; \alpha) + \nu$$

This gives us one equation for each indicator (i.e., each survey question). The integrated model consists of equations 1, 3, 9, and 10. Equations 1 and 3 represent the choice model and equations 9 and 10 represent the latent variable model. From equations 1 and 3 and an assumption about the distribution of the disturbances we derive the choice probability conditional on both observable and latent variables. The likelihood function includes complex multidimensional integrals, with dimensionality equal to that of the integral of the underlying choice model plus the number of latent variables. We estimate the integrated model using a simulation approach.

The changes incorporated into the new model allow us to estimate three sets of parameters using a nested method of moments algorithm. The first quantifies the effect of measured individual characteristics on tastes for product attributes. The second set measures the importance of unmeasured individual characteristics in determining preferences for product attributes. The third set allows us to estimate the effect of product attributes on the mean utility of a product. In other words, the first two sets give direct evidence on the extent to which the demand parameters can be explained by individual characteristics. The aggregate data is then used to estimate the additional parameters that determine the relationship between product attributes and the mean utility levels of the products.

By integrating a product choice model and a latent variable model of nutrition information as well as all of our data sources, we obtain precise estimates of the demand parameters that are crucial in determining consumer food choices over time. Understanding these determinants is central to the design of effective nutrition information programs and to the design of marketing

and promotion strategies by producers, manufacturers, and distributors. The results of the study contribute to precise answers to the question of how consumer information about nutrition affects individual food choices in the market place.

Data

We propose to analyze how consumer tastes, consumer characteristics (including knowledge of nutrition and nutrition label use), product characteristics (including nutritional content of foods), and manufacturers' marketing strategies (including advertising and brand strategies) influence individual food choices. Producing this comprehensive analysis requires the development and integration of multiple data sources that provide information relevant to the determinants of consumer food choice. These include IRI Info-scan^{TM} Data for quantities, prices, and in-store promotion levels; Nutritional Quality Change Data at the University of Massachusetts and Nutritionist Pro^{TM} Data at Rutgers University for nutrient content information; National Leading Advertisers Data for advertising expenditures; and USDA Diet and Health Knowledge Survey Data and Consumer Demographics Data for consumer characteristics.

We obtain data on market shares, prices, brand offerings, and in-store marketing efforts for all the brands in the selected food categories from the IRI Info-scan database at the Food Markets Branch, Economic Research Service, U.S. Department of Agriculture. These data are collected continuously by IRI using scanning devices in a national random sample of supermarkets located in 64 metropolitan and rural areas of the United States.

We match the IRI Info-scan quarterly market shares, prices, and other data for each brand with five other data sources. First, we match it to the nutrition composition data included in the Nutritional Quality Change Data developed at the University of Massachusetts and to Nutritionist Pro^{TM} Data available at Rutgers University. The IRI Info-scan data do not provide information on the amounts of nutrients contained in food products. Thus, information on market shares and prices has to be matched with information on the nutritional content of the respective brands from the other two data sources.

In order to obtain accurate information on the nutritional content of the products included in our analysis, we compare, evaluate, and complement two data sources. The Nutritionist Pro™ Data set is nutrition analysis software from First Data Bank. Nutritionist Pro provides nutrient analysis of diets, recipes, and menus. It has information on over 17,000 foods and ingredients, including brand-name foods, fast foods, and ethnic foods. The software was created based on data obtained from the USDA and various food manufacturers. By the nature of the software, the values of the nutrient contents are based on the estimated values of nutrients and these can differ from actual values. This data is used to complement the Nutritional Quality Change Data, which provides exact information on the nutritional composition of all products offered in a large super-store but does not contain information on all products offered at the national level. Nonetheless, the latter set includes 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 1992 through 1999. We create average nutrient content values based on similar brands for brands that appear in the scanner data but are missing from the two nutritional quality data sets.

Second, we obtain information on the distribution of consumer knowledge about nutrition and nutrition label use by sampling individuals from the Diet and Health Knowledge Survey (DHKS) conducted 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 their answers to questions concerning attitudes toward and knowledge of nutrition, food safety, and diet and health, as well as their use of nutrition labels. We use those questions from the DHKS that relate to knowledge about nutrition related to calories, fat, cholesterol, and sugar, and to nutrition panel use. We hypothesize that these factors play an important role in consumer food choices. Nutrition panel use can allow consumers to precisely evaluate the nutritional quality of foods they choose. All packaged foods have been required to carry nutrition panels since May 1994. By incorporating this information into our modeling, 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.

Third, we obtain information on the distribution of consumer demographic variables by sampling individuals from the Current Population Survey (CPS) carried out each year by the U.S. Bureau of the Census. Consumer per capita income is constructed by dividing household income by the size of the household. We also include other important demographic variables such as: education, age, percentage of elderly people, and percentage of women working. The CPS data are representative of the national population statistics from the Bureau of the Census.

Fourth, we match the IRI Info-scan data with the quarterly expenditures on advertising for each of the brands in the four product categories taken from the Leading National Advertisers database for 1993-2002. These data are collected for 11 different types of mass media (e.g., network television, spot television, cable networks, national spot radio, network radio, newspapers, magazines). We use the total average advertising expenditures on all 11 types of mass media.

Discussion and Conclusions

Consumer choices of food products take place in the market place and are influenced by many factors. Sims (1998) stressed the following two sets of factors: those external to the individual (and thus applicable to groups of people) and those that are idiosyncratic and specific to the individual. As the most important external factors Sims identified food, agricultural, and trade policies; available technology; food marketing; and group influence. On the other hand, the most important internal factors were one's genetic nutrient requirements, tastes, attitudes, health and nutrition knowledge, education, occupation, and income. Sims pointed out that those two sets of factors are interconnected.

In this paper we provide integrated analyses of the external (e.g., government information policy, food firms' marketing strategies) and the internal (e.g., tastes, nutrition knowledge and attitudes, education, income) factors that determine consumer choices of foods, as well as the links between them. Over the years, as the government and nutrition educators have stressed increasingly the relationship between diet and health, average per capita income in the United States has increased, making food more affordable for the average consumer. As people's

incomes rise, they place greater value on time and demand more convenient foods that are often less healthful (Aldrich 1999). In addition, Mojduszka et al. (2001) and Harris (1997) show that taste dominates nutrition in determining which frozen meal or frankfurter to consume. Overall, it appears that the factors of taste, food marketing, rising incomes, and convenience are outweighing nutrition and health information in determining demand for individual brands of food products. These trends, however, may not be inevitable. More studies are needed to provide a more comprehensive and systematic assessment of consumer food choices. In this sense, our study provides critical empirical results to inform ongoing policy debates relating to nutrition, advertising, consumer knowledge, and government regulation of information provision.

The rationale for this paper is to provide the in-depth analysis of current determinants of consumer food choices that can inform discussion of current consumption trends and their causes. Our goal is to be able to explain the apparent paradox discussed above that while consumers appear to be more knowledgeable about diet/health relationships, this knowledge is not translating very directly or in some cases at all into improved dietary choices, as well as other apparent paradoxes in patterns of consumer demand. Piecemeal analysis of aggregate trends or of consumer-level survey data can help to inform the discussion but are inherently limited in that they focus on one or only a few factors that influence demand at any given time. In reality, however, several determinants of demand are working simultaneously and what we see as market demand is the outcome of the interaction of these factors.

Our expansion and extension of prior work focuses on developing and estimating discrete choice models incorporating endogenous formation of consumer preferences. The motivation for this is that to date models have failed to account for the relationship between consumer preferences and knowledge about nutrition, advertising, and brand strategies. These preferences are unlikely to be exogenous so treating them as exogenously formed results in inaccurate estimates of the relative importance of different determinants of consumer food choices. Estimating consumer preferences as endogenous can correct for this problem.

The results of this paper are significant in several ways. The results give a comprehensive empirical picture of the relative importance and strength of factors influencing the actual brand-

level food choices of consumers. This information is useful to food producers and processors in analyzing the importance of different marketing strategies and in forecasting future shifts in demand. The information is critically important for policy makers as they make decisions related to information/labeling, public health, and education programs. For example, expected results from these programs may not materialize because while the factors they are targeting (e.g., consumer knowledge about diet/health linkages) do have some influence on consumer demand, this influence is currently swamped by other market forces. Clear understanding of current determinants of consumer food choice can inform policy choices that rely on enhancement of these factors. Finally, the results of the paper contribute new, more comprehensive modeling and empirical approaches to brand-level demand estimation.

The most innovative and unique aspect of this work is that it moves beyond the studies described in the introduction to integrate several behavioral models and data sources. As a result, our conclusions provide important insights into the economic forces that tend to limit the efficient provision and use of nutrition information in consumer choices of foods. This work differs from other research in this area in several respects. First, the dependant variable focused on is the market share of a particular brand of food product in its product category. This allows a direct analysis of the relative competitive effects of different product attributes on demand as well as of the effect of consumer characteristics on demand. Second, the development by the authors of brand-level nutritional profiles allows much more specific and reliable analysis of the nutritional quality of competing brands. Third, this approach makes full use of and expands the discrete choice approach to modeling demand for differentiated products.

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