ABSTRACT

CHOI, HEE JUNG. Three Essays on the Welfare Effects of Organic Milk Introduction. (Under the direction of Dr. Michael Wohlgenant.)

This study investigates the impact of organic milk introduction on consumer benefits employing two different demand approaches; multistage demand system approach and discrete choice approach. These two approaches with A.C. Nielsen Homescan data allow analyzing the dairy market at the various levels of the economy.

In the first essay, the aggregate demands for milk products at both brand level and commodity group level are analyzed adopting the multistage demand system approach. Expenditure functions are derived from the estimated demand equations to quantify the welfare changes. The welfare effect is decomposed into the variety effect and the price effect, where the former is the willingness-to-pay changes for having more options to choose and the latter is the amount of price changes in existing products due to enhanced competition. Unlike the previous demand studies on milk market, the elasticity results indicate that there is no evidence of substitutability between organic and conventional milk products when milk is categorized by both fat contents and organic claims. Rather, this study shows that milk products with similar fat content are substitutable to each other. The estimated variety effects indicate that consumers benefit significantly from the organic option as much as 8% of milk expenditure. The price effects show some evidence of cannibalization in this market over the period of analysis.

In the second essay, the same economic questions are answered in the discrete choice approach. Employing a mixed logit model and individual household level data, this essay considers not only the observed characteristics of product and household but also unobserved characteristics and tastes in the analysis. The variety effect is estimated for each individual household and, as a result, the entire distribution of the variety effects that can answer the question of which type of households benefit the most from the introduction of organic milk is presented. Both utility parameter estimates and the distribution of variety effects indicate

that households with younger head, higher income and higher education benefit more from organic milk introduction than ones with older head and lower income and education.

The third essay extends the second essay with supply side study to analyze the price effect in a partial equilibrium framework. Counterfactual prices in the absence of organic milk are predicted by solving the first order conditions of firms’ profit maximization under the assumption of Bertrand-Nash competition. The mean values of counterfactual prices based on the mixed logit analysis imply that firms decreased the prices of existing prices due to the enhanced competition in the market.

Three Essays on the Welfare Effects of Organic Milk Introduction

by
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DEDICATION

To Mom and Dad

BIOGRAPHY

Hee-Jung Choi was born on December 12, 1978 as the daughter of Joo-Young Choi, a civil engineer, and In-Sook Park, a paint artist. She lived in Seoul, Korea with her parents and her younger brother until she left the country to study in the U.S. Following her graduation from Daewon Foreign Language High School she enrolled at Ewha Womans University in 1998 and received Bachelor degree in Economics in 2002. During her college years she actively participated in concerts and fundraising activities as a member of Ewha Symphonious Amateur Orchestral Sounds. Upon earning her Master degree in Economics from the State University of New York at Albany in 2004, she went back to Korea to work for Korea Development Institute (KDI) as a research assistant. During her work at KDI, she participated in various research projects from analyses on government policy and program to forecasting macroeconomic indices. After two years' experience, she decided to develop further her research skills and started pursuing a Ph.D. In her second year at North Carolina State University, she found her research topics inspired by the courses taught by Drs. Wohlgenant and Zheng whom later became her advisor and committee member, respectively. Her research interests concentrate on applied microeconomics, agricultural economics and applied econometrics.

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Finally, I thank my Lord and Savior Jesus Christ who planned every step of this academic journey and led me where I am now. I thank you, Lord. Here I humbly lay my first-fruits and leave the next steps in your hands again.

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CHAPTER 1

The Welfare Effect of Organic Milk

I. Introduction

Recent innovations in agricultural industry make new products, such as Genetically Modified (GM) food and Organic food, available to consumers. Although various opinions on the effect of GM food products are not in agreement among nutrition experts, consumers' concern on health and environment increases demand for organic food products. This study analyses the structural changes driven by organic food introduction into the U.S. food sector in terms of its welfare effect. According to the Organic Trade Association (OTA), organic food sales in the U.S. were $13.8 billion in 2005, which is 2.5% of total food sales. This is an increase from 1.9% in 2003 and from 0.8% in 1997. Increasing trends of demand are expected to continue and estimated to rise to $23.8 billion by 2010 (Nutrition Business Journal, 2004). Public policy also played a significant role in the expansion of organic food sector. The National Organic Standards, which is implemented by the U.S. Department of Agriculture (USDA) in 2002, specify the production process for processing, distributing, and growing organic food. The policy also restricts the use of Organic logo by allowing it only to the products whose profile meets the standards. Consumers are not only exposed to more information on organic standard by this policy adoption, but the logo also provides an easy way for consumers to recognize qualified organic products.

As part of the organic food market, organic milk market has also been growing. According to the USDA, organic cow milk and soy milk drinks are the top two categories among processed organic products other than fresh products. Organic milk first appeared in conventional supermarkets in 1993 and 8 conventional supermarkets were selling organic milk in 1996 (Glaser and Thompson, 2000). After the introduction of organic milk in the market, sales of organic milk have been growing; organic milk and cream sales increased from $15.8 million to $104 million, from 1996 to 2000. The industry shows a dramatic increase in sales during the early 2000s, which coincides with the implementation of National Organic Standards[1] in 2002 and a price increase of conventional milk in 2004. As of 2005, organic milk and cream sales were over $1billion, which is 25% up from 2004 sales. A noticeable fact is that overall sales of milk have remained constant since the mid-1980s, which indicates that organic milk sales not only increased, but also expanded in its market share in overall milk industry (Miller and Blayhey, 2006). This also implies that not only new firms entered the organic milk industry during the past years, but also existing firms increased the supply of organic milk by recruiting and assisting conventional milk producers converting their product to organic milk[2]. (USDA, Retail and Consumer Aspects of the Organic Milk Market)

As interest in organic market grow, agricultural researchers have conducted some studies on organic milk. An earlier study by Glaser and Thompson (2000) considers demand for branded milk, private label milk and organic milk based on supermarket scanned data collected from 1988 to 1999 by AC Nielsen and Information Resources, Inc (IRI). According to the study, demand elasticities computed from nonlinear Almost Ideal Demand System (AIDS) framework indicate that organic milk demand is more elastic than private-label and branded milk. Although this analysis well describes the sensitivity of organic milk demand in the early stages of introduction, it cannot account for the current market analysis because the

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[1] Organic dairy products, as defined by USDA, are made from the milk of animals raised organic management. The animals are raised separately from the herd of conventional dairy animals. The animals are not given hormones or antibiotics. The animals receive preventive medical care, such as vaccines, and dietary supplements of vitamins and minerals. (Recent Growth Patterns in the U.S. Organic Foods Market, USDA)

[2] To convert from conventional to organic production, the cow must be fed a diet consisting of at least 80 percent organic feed for 9 months and then 100 percent organic feed for 3 additional months, or must be grazed on land that is managed under a certified organic plan. (Recent Growth Patterns in the U.S. Organic Foods Market, USDA)

organic market has grown competitive to the extent that private label milk suppliers also produce organic milk.

The type of consumer more likely to purchase organic products has also been of interest to marketing researchers. Lohr (2001) characterizes organic consumers as White, affluent and well-educated. Lohr and Semali (2000) conclude that parents of young children or infants are more likely than those without children to purchase organic food. Dimitri and Venezia (2007) provide descriptive statistics on the socio demographic characteristics of organic milk consumers using 2004 Nielsen Homescan panel. They also conclude that the typical organic milk consumer is white, well-educated and living in a household headed by someone younger than 50 years old, which is not different from the description on general organic consumers studied by others. Alviola and Capps (2008) provide a more formal statistical analysis with the same data as Dimitri et al. implementing Heckman two-step procedure. Their conclusion largely agrees with Dimitri et al.

However, there are very few studies on the welfare effect of the introduction of organic products. Dhar and Foltz (2005) estimate a demand system for recombinant bovine growth hormone (rBST) free labeled milk, organic labeled milk, and unlabeled (conventional) milk utilizing the quadratic AIDS framework and full information maximum likelihood estimation techniques. The data used for the analysis consist of weekly sales and prices from 1997 to 2002 in twelve cities over the U.S. They find that organic milk and rBST-free milk are complements to each other, while unlabeled milk is a substitute for both rBST-free and organic milk. In addition, the amount of consumers' benefit from the specialty milks is analyzed through the price effect (PE) and variety effect (VE), where the former implies the amount of price reduction by existing competitors after the introduction of a new competitor and the latter is the willingness-to-pay changes for having more options to choose. They claim that consumers will benefit 2 cents per gallon by the price reduction in unlabeled milk (CE) and 17 cents from the option of having rBST-free and organic milk. However, this research has some limitations. First, the data and categorization used in the analysis is likely outdated because of the rapidly changing organic milk market. As mentioned above, the National Organic Standards, as well as many media reports on health issues, contributed to changing consumers' perception of organic milk. Hence, it is very likely that consumption patterns on organic and conventional milk changed after this policy. This idea can be supported by the report that more consumers have bought the higher premium especially after 2002 (Dimitri et al, 2005). Consumers' concern on health risk and retailers' response also changed the structure of milk market. The nation's largest diary process, Dean Foods, no longer sells rBST treated milk, and the top 3 grocery retailers, Wal-Mart, Kroger, and Costco, claimed not to sell such milk in their stores. Therefore, rBST treated milk is not in the product space for most of consumers after the early 2000s; hence, the categorization used in their study will not be valid any longer. Second, the model does not control other relevant factors such as fat contents or flavor. Based on the fact that consumers' preference on fat contents has been changed as their concerns on fat consumption increase, it is possible that this model over states the welfare effect of organic milk.

In the early stage of introduction of organic milk, there existed only two organic milk suppliers in the nation, Organic Valley and Horizon Organic, and they were available in some limited areas. Thus, the structure of competition in milk market is rather between organic milk and non organic milk. As the organic milk market has expanded, however, the competitive structure has also changed to the extent that there are several national and local brand organic milk plus private-labeled organic milk carried by conventional supermarkets. Therefore, in order to establish an appropriate analysis of current milk market, the competition at the brand level rather than commodity group level should be taken account into the model.

In this light, the objective of this study is to analyze the demand for organic and conventional milk at both brand level and commodity group level. A brand level milk product is defined by its fat contents, organic claim, flavor and the name of the supplier. A group commodity milk is defined by its fat contents, organic claim and flavor. Detailed explanations on categorization will be provided in the data section. AC Nielsen Homescan data from 2004 to 2005 is used for the study[3]. The multi-stage demand approach is used to estimate the demand for milk products at the brand level following Hausman (1997). The Linear Approximate AIDS (LA/AIDS) model is adopted for the functional form of demand equations. Unconditional (on the expenditure) elasticities among brands and group commodities are estimated using the methodology suggested by Carpentier et al.(2001). In addition, the welfare effect of the introduction of organic milk will be analyzed.

Previous studies on brand level demand analysis are reviewed in section II and descriptive statistics from Nielsen Homescan data are presented in section III. Section IV explains model specification and estimation techniques for demand analysis and the results are shown in section V, and the welfare analysis is provided in section VI.

II. Demand Estimation for Differential Goods

Researchers have been interested in developing methodologies to estimate demands for differentiated goods as disaggregated data and advanced computational devices have become available. For example, Hausman et al. (1994) proposed a multi-stage demand system with an application to beer market and Berry et al. (1995) introduced mixed logit approach with an application to automobile demand. Although the applications to differentiated goods and disaggregate data are recent innovations, their basic ideas are from the existing demand approaches. In this sense, the development of classical demand approaches is briefly discussed and two representative demand approaches in differentiated goods context are discussed.

[3] AC Nielsen established organic variable since 2002, but the data before 2004 imply that organic cow milk is not introduced or the consumer perceptions of organic products are lacking in the market this study focuses on. The recorded organic purchases before 2004 are occurred in soy milk category. Therefore, the data from 2004 to 2005 are used for demand estimation and price values before 2004 are used to calculate the price effect.

1) Classical Approach

Since Stone (1954) derived the very first demand system, Linear Expenditure System (LES), by imposing theoretical restrictions on a simple linear demand system, researchers have developed various functional forms of demand equations to reflect the reality better so that be able to test whether the theoretical restrictions are true. Theil (1965) and Barton (1966) derived Rotterdam model (RM) by substituting Slutsky decomposition into a differentiated double log demand function. Homogeneity, symmetry and negativity are tested, but Barton finds that the empirical results of RM are consistent with theory only with the application to highly aggregated data while disaggregated applications conflict with theory. Different approaches that give more functional flexibility to the model were suggested by a great number of researchers in order to find a model consistent with theory. The basic idea of flexible functional forms is to approximate direct utility function, indirect utility function or cost function by some specific functional forms and give it enough parameters so that it is flexible enough to approximate an arbitrary utility or cost function. The demand functions are derived through duality. Christensen, Jorgenson, and Lau (1975)'s translog model approximates the indirect utility function by a quadratic function of logs of normalized prices, and derive Marshallian demand by Roy's identity. The authors also test theoretical restrictions, but homogeneity does not hold for this model. Another famous approach known as Almost Ideal Demand System (AIDS) is introduced by Deaton and Muellbauer (1980). The model is derived from the cost function of generalized Gorman polar form using Shephard's lemma. The test with this model is also inconsistent with theoretical restrictions.

As summarized above, a list of conventional demand systems has been developed in the past in efforts to find flexible functional forms that are close to reality, and those proposed models were tested to examine whether the models are consistent with consumer theory. Empirical evidence implies that currently available demand models and data fail to support the theoretical restrictions. Researchers appear to have different interpretations on the results. Some researchers, such as Christensen et al., conclude that the theory of demand does not hold. But most researchers, such as Deaton and Muellbauer, carefully conclude that none of the existing models perfectly define demands and measure elasticies, and estimate the best approximation imposing the theoretical restriction.

2) Logit Approach

McFadden (1974) argues that the conventional demand approach assumes all individuals in a population have a common behavioral rule. The logit model starts from the indirect utility functions of individuals instead of a "representative" utility, taking account heterogeneity of individual tastes. The indirect utility function consists of common utility and random utility. Based on the revealed preference theory, probability of choice can be presented as an integral of cumulated joint density functions. This probability directly can be interpreted as the share of demand, but it has to be transformed into a closed form of a function for estimation purpose. Luce (1956) derived the probability of choice formula from the conditions satisfies Independence of Irrelevant Alternative (IIA). McFadden (1974) derived the same probability of choice formula under the assumption of Gumbel distribution for the error terms.

A nice feature of logit models is that the tastes that vary systematically with respect to observed variables can be captured while the tastes that vary with unobserved variables cannot be handled. Also, the logit models solve the problem of having large number of parameters which conventional demand system suffers from because the indirect utility functions in discrete choice model are not defined with the prices of all the products in the system. However, the substitutability in logit models is very restrictive. Since logit models exhibit the independence of irrelevant alternatives (IIA) property, it constrains the cross price elasticities. The IIA claims that the ratio of choice probabilities between two goods does not change even if the third irrelevant good is introduced. This might be a plausible assumption in some cases, but it is not behaviorally accurate in many cases.

Nested logit models have been used to overcome the limitations of IIA (Ben Akiva 1973, Train et al. 1987). The approach is based on the assumption that consumers make decisions in sequence. Consumers would choose whether to participate in the economic activity in question, then select a specific choice. Within each data step, the IIA assumption holds. However, across different steps, the ratio of probabilities can depend on the attributes of other alternatives in those nests and IIA does not hold. Nested logit approach is still limited in its ability to account for unobserved preferences. To relax the IIA assumption and account for heterogeneity, the mixed logit model is used (Train et al. 1987 and Berry 1995). It is an extension of standard logit that allows the coefficients to vary across individuals by assuming the coefficients have distributions rather than fixed numbers.

3) Multi-stage Demand

Hausman et al.(1994, 2002) apply Gorman's multi-stage budgeting approach into the demand for differentiated products. Strotz (1957) discussed that consumers allocate expenditure among broad groups of commodities in the first stage of budgeting, and then allocate individual commodities within each group if the utility function is separable. Gorman (1959, 1971) developed Strotz's discussion in detail. He argues that 'separability' is not enough to explain the consumer's multi-stage budgeting behavior. He shows that, under the assumption of 'weak separability', consumers allocate their income into broad groups of commodities at higher stage of budgeting and more detailed within-group allocation happens at lower stage. Weakly separable preferences allow the last stage demand functions to be presented only with the group expenditure and the prices of products within that group. However, in order for the higher stage demand functions to be expressed with total expenditure and the price indices of each group, additive separability and Gorman generalized polar form of indirect utility functions, or homothetic preference is required.

Hausman et al. apply this approach to estimate the brand level demand in beer market, whereas Gorman's original approach is conducted at the aggregate level of economy. The basic idea of this model is to let the top level demand corresponds to the overall demand of beer, and the middle level demand corresponds to the demands for different segments of beers. The lowest stage of the demand system corresponds to each brand of beer. The underlying assumption of separability eases the problem of dimensionality where the system of demand equations suffered from its numerous coefficients to estimate. Weak separability is assumed at the lowest level of utility maximization problem so that the demand for each brand can be presented as a function of group expenditure and the prices of own and other brands in the same group. Additive separability is required at the higher stage of utility maximization in order for the higher stage demand to be presented as a function of total beer expenditure and price indices of segments. Although additive separability has nice features which reduces the number of coefficients allowing the demand function to be written with group price and quantity indices instead of commodity prices, it is not a realistic nor plausible assumption. Hausman does not explicitly discuss the assumptions for the higher stage demand, but it seems that he adopts Carpentier and Guyomard's (2001) approximation of first-stage allocation process instead of imposing additive separability. Carpentier states that, if preferences are weakly separable and the group price indices being used do not vary too greatly with the utility level, allocation between groups of commodities by two stage budgeting will be consistent with unconditional demand analysis, thus the first stage demand function with price index can be approximately rationalized without a strong assumption.

III. Data

As mentioned above, the data used in this study are the Nielsen Homescan panel data. The sample is selected among volunteers based on both demographic and geographic targets. Stratification is done by AC Nielsen to ensure that the sample matches the U.S. Census. The panelist members are required to scan the items purchased with handheld scanner and transfer the information to AC Nielsen each week identifying purchase date. Unobserved data should be interpreted as infrequency of sales rather than infrequency of records since it is mandatory for the members to transfer data every week. If a member fails to comply with the rule and does not report more than a month, then the panelist membership is terminated.

The nationally representative sample consists of purchase histories of milk products by 49,114 households from 2002 to 2005. 8,866 households participated in 2002, 18,539 households in 2003, 40,327 and 37,338 households in 2004 and 2005 respectively. The sample contains information on demographics such as income, household size, age of head, number of child, employment, education and race. Demographic distributions are presented in TableI-1. Half of the sample is from under $45,000 income class and the other half is from above $45,000 income class. More than half of the households consist of single or two members, and 75 percent of the sample have no children under 18. 72 percent of male or female household heads are employed more than 30 hours a week and 70 percent of them have at least college degree. The shares of organic milk purchase by different demographic characteristics are provided in Table I-2. Households with small number of members tend to purchase more organic milk than large families do. Middle income class is less likely to purchase organic milk than low income or high income class. Also, the data show that the households only with under-6-year-old children are relatively more likely to purchase organic milk than any other households.

A number of physical product characteristics, weekly prices and quantities purchased are also included in the data. For simplicity, milk products are differentiated with a few important characteristics such as fat contents, flavor and organic claim[4]. The fat contents are categorized into five types in this study; non-fat, 1% low fat, 2% reduced fat, whole milk and soy&lactose-free milk. Flavor is categorized into flavored and not flavored. Table I-3 provides the market shares of products distinguished by these characteristics each year. 2% reduced fat milk brings the largest share of milk sales up to 35% during the period, and the market shares of 2% milk and whole milk have decreasing trends while the shares of non-fat, low fat and soy&lactose-free milk have moderately increasing trends. The share of organic milk also shows an increasing trend in this sample.

In this study, a product is defined at the brand level with four different characteristics of products; fat contents, organic claim, flavored or not and the name of manufacturer. Many kinds of flavors are consolidated into “flavored” for simplicity. Different fat contents produced by the same manufacturer are treated as different products, and organic milk and

[4] Some of variables such as fat contents and flavors are not precisely recorded so that those variables are created from the UPC (Universal Product Code) description.

non-organic milk of a same producer are treated as different products as well. Different brands with same fat contents, flavor and the same organic claim are, of course, regarded as different products. But different sizes and different types of containers are not distinguished in the products defined in this study. The commodity groups are aggregated across different brands with the same characteristics. For example, the commodity group of 2% reduced fat-organic-unflavored milk is an aggregation of different brand names within the group of 2% reduced fat-organic-unflavored milk. Hence, there are 20 group commodities with the categorization mentioned above. The quantities of group commodities are the aggregation across brand level products with same characteristics and their prices are the price indices of each group. In terms of time frequency, weekly purchase data are aggregated into monthly records in order to minimize infrequency problem. According to the definition of product above, there exist 1,902 products in the nation. However, it is notable that specific brands of milk appear only in specific areas and only a few brands dominate the local markets while a large number of residuals take only 1~5% of market share. Hence, it is concluded that the brand-level milk market is highly localized and dominated by a few brands so this study needs to focus on some specific market. Raleigh-Durham-Chapel hill and Charlotte markets are chosen and brands with market share larger than 1% are considered.

1,634 households participated in the survey from 2002 to 2005 in RDU (Raleigh-Durham-Chapel hill and Charlotte) area. 103 households participated in 2002, 481 households in 2003, 1440 households and 1319 households in 2004 and 2005 respectively. Among the panelists, 471 households participated for one year and 1004 households participated for two years. There are 80 households and 47 households who participated for three and four years, respectively. The demographics in this area show similar features as the national demographics. However, although AC Nielsen established organic variable since 2002, the data before 2004 imply that organic cow milk is not introduced or the consumer perceptions of organic products are lacking in this market. Or AC Nielsen’s categorization might not be accurate before 2004. The organic purchases are occurred only in soy milk category according to the data during 2002 and 2003. Therefore, the data from 2004 to 2005 are used to estimate consumer demand and the welfare effects are analyzed under the assumption that organic cow milk is introduced in this area since 2004. The price values of conventional milk prior to 2004 are used to calculate the price effects in the welfare analysis. The shares of each type of milk sales are described in Table I-4. The figures are similar to the national sample. The organic milk takes about 2.5 percent of the milk market and the 2% reduced fat milk takes the largest share.

There exist 249 products in the area, but only 58 products take more than 97% of the milk market. Hence, only the 58 products are included in this study. The products can be categorized into 20 groups according to the characteristics mentioned above, which are fat contents, flavor and organic claim. Market shares and average prices of products in each group, and the number of brands with larger than 1% of market share within each group are shown in Table I-5. Conventional non-flavored non-organic milk dominates the market with 92% market share. Soy and lactose free milks are priced higher than cow milk among non organic milk. Organic cow milk has higher per unit prices than conventional cow milk as expected, but soy and lactose free milk are not priced differently between organic and non organic.

IV. Model

1) Multi Stage Demand System

Hausman's three stage demand system approach is adopted to estimate the demands of milk. The first stage demand is defined as total demand of milk; the second stage is defined as demands for group commodities; the third (lower) stage estimates brand level demands within groups. It is assumed that the direct utility function is weakly separable into sub-utilities and the current weighted true cost of living price indices for each groups vary only slightly with corresponding sub-utility levels so that the empirical variation of price index with sub-utilities can be neglected. The latter assumption allows to avoid strong assumptions, such as strong separability or homothetic preference, in the upper stage of demand system (Carpentier and Guyomard, 2001). The econometric functional form of brand level demand equation is specified as Linear Approximate Almost Ideal Demand System (LA/AIDS):

$$(1) \qquad w_{it} = \alpha_{it} + \sum_{j=1}^{n} \gamma_{ij} \ln(p_{jt}) + \beta_i \ln\left(\frac{m_t^G}{P_t^G}\right) + \varepsilon_{it}, i, j \in G, i, j = 1, 2, ..., n$$

where $i = 1, 2, ..., n$ denotes the brands of milk in group G and t denotes time period. p_{jt} are the price of product j consumers face in time period t. m_t^G are total group expenditure on group G in period t, that is, $m_t^G = \sum_{i=1}^{n} p_{it} q_{it}$ and ε_{it} is an error term. P_t^G is the Linear Approximate AIDS price index of brands in group G period t.

In order to estimate the group commodity demand in the second stage, Stone Index is computed for the price indices of each segment using mean values of market shares of each brand. LA/AIDS is used to specify the middle level equation. (Hausman states in his paper that the difference in functional form does not make difference in outcomes.)

$$(2) \qquad q_{mt} = \beta_m \log \frac{y_{Bt}}{P_t^B} + \sum_{k=1}^{M} \delta_{ij} \log \pi_{kt} + e_{mt}$$

m = 1, …, M, t = 1, …, T

where q_{mt} is the share of segment m in period t, y_{Bt} is total milk expenditure, and π_{kt} is segment price indices in the period of t.

The first level equation, which explains the overall demand for milk, can be specified as

$$(3) \qquad \log u_t = \beta_0 + \beta_1 \log y_t + \beta_2 \log \prod_t + Z_t \delta + e_t$$

where u_t is overall consumption of milk, y_t is disposable income, π_t is price index for milk, and Z_t are the variables that account for time trends.

2) Specification and Estimation

As I mentioned above, data used in this study are micro-level survey data. When it comes to demand analysis using this type of data, one cannot avoid the issue that some products are not consumed by at least some economic agents in some periods. Even though the data used in this study for the lower level of multistage demand equation are not disaggregated as to the household level, the data are still disaggregated to some degree of brand level and indicate zero purchases for some brands in some periods.

Setting aside the difficulties of estimating latent dependent variable models, missing regressor difficulties are first encountered because prices are not observed for non purchased products. Three simple solutions for this problem are 1) to discard all incomplete observations and estimate population parameters using the remaining observations, 2) to use zero-order methods which substitute sample means for the missing values, and 3) to use first-order methods which substitute predicted values from simple regression for the missing values. However, these methods are criticized because of sample selection bias. Many researchers suggest various missing value procedures mostly utilizing demographic or product characteristics. For example, Heckman procedure and Amemiya's principle require both regressands and regressors in demand systems to be endogenous so that the variability of regressors can be explained with other exogenous variables. However, in multi-stage demand approach, it is difficult to incorporate quality adjusting price equations because the assumption of separability does not allow volatilities in the exogenous variables that explain price variation, such as characteristics of products. Therefore, a simple regression method seems to be the only feasible approach to treat the missing price problems. The unobserved unit prices are predicted following Perali and Chavas (2000). The unit prices at UPC level were regressed on characteristics variables, time variables, regional dummies, and interaction terms between characteristics and time variables. The least square results show 0.54 of R-square, but the coefficient estimates are statistically significant at 10% level.

Another issue with regard to using micro-level purchasing data is to take the zero purchasing behavior of consumers into account in analysis. This indicates corner solution outcomes of consumer utility maximization problem, which are rational decisions of economic agents. Thus, a Tobit model is suggested to explain the corner solutions.

$$w_{it} = \begin{cases} w_{it}^* & if \ \ w_{it}^* > 0 \\ 0 & if \ \ w_{it}^* \le 0 \end{cases}$$

Assuming random utility hypothesis (RUH) and PIGLOG class utility function, the Marshallian uncompensated demand functions at the household level can be specified as follows:

$$(4) \qquad w_{iht}^* = \alpha_{iht} + \sum_{j=1}^{n} \gamma_{ij} \ln\left(p_{jht}\right) + \beta_i \ln\left(\frac{m_{ht}^G}{P_{ht}^G}\right) + \tilde{\varepsilon}_{iht}, i, j \in G, i, j = 1, 2, ..., n$$

where $i = 1, 2, ..., n$ denotes the i 's milk product in the demand system, h denotes the household, t denotes the time period. p_{jht} is the price of product j household h faces in time period t. m_{ht} is household h 's total group expenditure on milk products in period t, that is, $m_{ht}^G = \sum_{i=1}^{n} p_{iht} q_{iht}$ and P_{ht}^G is the Linear Approximate AIDS price index for household h in period t. $\tilde{\varepsilon}_{iht}$ is an error term that is heteroskedastic within the share equation for one good and correlated across the share equations for different goods. $\tilde{\varepsilon}_{iht} = \varepsilon_{iht} - \beta_i \sum_j \ln p_{jht} \varepsilon_{jht}$. ε_{jht} is mean zero homoskedastic error term from utility function.

$$(5) \qquad \log P_{ht}^G = \sum_{i=1}^{n} w_{ih}^0 \log(p_{iht}) \text{ where } w_{ih}^0 = \frac{1}{T} \sum_{t=1}^{T} w_{iht} .$$

Household heterogeneity α_{iht} might be specified as

$$(6) \qquad \alpha_{iht} = \rho_{i0} + \sum_{k=1}^{s} \rho_{ik} d_{kht} + \rho_{i(s+1)} t + \rho_{i(s+2)} t^2 + c_h$$

Since I have aggregate data, however, the demand function above should be aggregated over households. Aggregating (4) over household yields

$$(7) \qquad w_{it}^{*} = \alpha_{it} + \sum_{j=1}^{n} \gamma_{ij} \ln\left(p_{jt}\right) + \beta_{i} \ln\left(\frac{m_t^G}{P_t^G}\right) + \tilde{\varepsilon}_{it}, i, j \in G, i, j = 1, 2, ..., n$$

where

$$w_{it}^{*} = \frac{\sum_h m_{ht} w_{iht}}{\sum_h m_{ht}}, \qquad \tilde{\varepsilon}_{it} = \frac{\sum_h m_{ht}^G \tilde{\varepsilon}_{iht}}{\sum_h m_{ht}^G}, \qquad \alpha_{it} = \rho_{i0} + \rho_{i1} t + \rho_{i2} t^2$$

Therefore, heteroskedastic Tobit model with the two-step estimation approach is adopted for the lower stage demand estimation.

The first and the second stage demand do not require Tobit approach because the aggregated data used in the higher stage do not show the evidence of corner solution outcomes. However, the error terms might not be homoskedastic any longer. Based on the assumption of Random Utility Hypothesis, disturbances of uncompensated demand functions will be heteroskedastic according to the same logic provided above. Hence, the conventional demand systems given in equation (2) and (3) with SUR approach are adopted for the higher stage demand estimation.

Two step estimation

Estimating censored demand system is not an easy task because it involves multiple probability integrals. In the early applications (Wales and Woodland (1983), Lee and Pitt (1986, 1987)), researchers were only able to analyze small systems by taking multiple integrals. Because of recent development in simulation techniques, researchers can numerically evaluate multiple probability integrals and some alternative methods with large system applications are suggested. An application of the simulated maximum likelihood (SML) approach is seen in Kao, Lee and Pitt (2001), and the quasi maximum likelihood (QML) approach which approximates the multivariate likelihood function with a sequence of bivariate function can be seen in Yen, Lin and Smallwood (2003). An alternative that does not involves complicated computational tasks, which is known as two-step estimation, is proposed by Perali and Chavas (2000) and later extended to the panel data framework by

Meyerhoefer, Ranney and Sahn (2005). This study adopts Meyerhoefer's two-step estimation because the approach is generalized to the application of panel data while others are applied only with cross-section data and its computational procedure is relatively simple comparing to other approaches.

The basic idea of the two-stage procedure is to estimate an unrestricted heteroskedastic Tobit model equation by equation and find the error correlations, and then recover restricted parameters using the minimum distance method which falls into the GMM framework.

In the first step, the share equation for ith product presented by equation (7) can be rewritten as follow if time variables are dropped.

$$(8) \qquad w_{it}^{*} = \rho_{i0} + \sum_{j=1}^{n} \gamma_{ij} \ln\left(p_{jt}\right) + \beta_i \ln\left(\frac{m_t^G}{P_t^G}\right) + \tilde{\varepsilon}_{it}, i, j \in G, i, j = 1, 2, ..., n$$

$$\text{where } \tilde{\varepsilon}_{it} = \frac{\sum_h m_{ht}^G \tilde{\varepsilon}_{iht}}{\sum_h m_{ht}^G}, \qquad \tilde{\varepsilon}_{iht} = \varepsilon_{iht} - \beta_i \sum_j \ln p_{jht} \varepsilon_{jht} .$$

ρ_{i0} is product specific fixed effect. As $\tilde{\varepsilon}_{iht}$ is heteroscedastic within each equation and correlated across equations, so is $\tilde{\varepsilon}_{it}$. To get consistent first-step estimates, a heteroscedastic Tobit econometric model is employed for each equation. The variance of the error term is specified using a fairly flexible and general form

$$(9) \qquad Var(\tilde{\varepsilon}_{it}) = \sigma_i^2 \exp\left(z_{it}^{'} \xi_i\right)$$

where z_{it} is a s_z -dimensional vector of variables for product i in period t. Variables of t, t^2, $\log p_{it}$ and $\log \frac{m_t^G}{P_t^G}$ were included in z_{it} at first, but only $\log \frac{m_t^G}{P_t^G}$ is included because the other variables seem to hamper the optimization procedure without improving the goodness of fit of the model. As the estimation is conducted for each share equation separately without imposing cross-equation parameter restrictions implied by demand theory, the estimates I obtain from this step are reduced form estimates. In order to recover restricted estimates, reduced form parameter estimates are collected in the vector $\hat{\pi} = \left(\hat{\pi}_1^{'}, ..., \hat{\pi}_n^{'} \right)^{'}$, where $\hat{\pi}_i$ is a $(n + s_z + 2) \times 1$ vector of reduced form parameter estimates from the i 's equation. In the second step of estimation, the cross equation restrictions implied from demand theory are imposed on the reduced form parameters estimated in the first step, and the structural parameters that are consistent with demand theory are calculated. Denote a q-dimensional vector of structural parameters as ψ, then the structural parameters are obtained from the following GMM estimation procedure

$$(10) \quad \min_{\psi} \left[\hat{\pi} - h(\psi) \right]^{'} \hat{\Omega}^{-1} \left[\hat{\pi} - h(\psi) \right]$$

where $h(\psi)$ is a nonlinear mapping ψ into π that is used to impose the theoretical restrictions on the reduced form parameters. The number of restrictions imposed is $(n + s_z + 2) \times n - q$, which is equal to (n-1)*n/2+n+2. Under the null hypothesis that these restrictions are correct, the minimized value of objective function (10) is a chi-square distributed random variable with degree of freedom equals to the number of observation minus the number of restrictions.

The difficulty arises in finding a consistent estimate of Ω. Meyerhoefer et al. (2005) states that the covariance-variance matrix for $\hat{\pi}$ takes the form $\Omega = D_1^{-1} D_2 D_1^{-1}$ and the proof is provided in his unpublished dissertation (2002). If $g_t = \left(g_{1t}^{'}, ..., g_{nt}^{'} \right)^{'}$ denotes the vector of univariate scores from all of the n equations corresponding to the observation in period t, and H_{it} the univariate Hessian from the i 's equation for the same observation, then $D_1^{-1} = diag\left\{ E(H_{1t})^{-1}, ..., E(H_{nt})^{-1} \right\}$ and $D_2 = E\left(g_t g_t^{'} \right)$. A consistent estimator for Ω can be obtained by replacing the population moments by their sample counterparts. However, this might not work for this study because the data used in this study do not meet with the condition for large sample theory. These are two years' monthly data so that the number of observations for each brand is at most 24. The data for specific types of milk such as organic milk are established recently, thus very short strings of data are available for special types of milk.

The finite sample properties of GMM estimator seem to be an interesting topic among the econometricians in mid 90s. The July 1996 issue of Journal of Business and Economic Statistics is full of papers on the small sample properties of GMM estimator proposing alternatives for consistent estimator of weighting matrix. Although they are looking at slightly different issues of small sample properties, their conclusions converge to one that the equally weighted matrix, which is equivalent to identity matrix, dominates covariance matrix (or the proposed matrix) in terms of the bias of estimator and coverage probabilities. Therefore, the identity matrix is used in this study.

Elasticities

The unconditional expectation for the budget shares including all the observations is

$$(11) \quad E(w_{it}) = \Phi_i(\bullet) \times \left[\rho_{i0} + \sum_{j=1}^{n} \gamma_{ij} \ln\left(p_{jt}\right) + \beta_i \ln\left(\frac{m_i^G}{P_i^G}\right) \right] + \sigma_i^2 \exp\left(z_{it}^{'} \xi_i\right) \times \phi_i(\bullet)$$

$$\text{where} \quad \bullet = \frac{\left[\rho_{i0} + \sum_{j=1}^{n} \gamma_{ij} \ln\left(p_{jt}\right) + \beta_i \ln\left(\frac{m_i^G}{P_i^G}\right) \right]}{\sqrt{\sigma_i^2 \exp\left(z_t^{'} \xi_i\right)}}$$

The uncompensated own price, cross price and expenditure elasticities that are conditional on the group expenditure but unconditional on whether the observed budget share is zero or positive can be derived as

$$(12) \quad e_{iit} = -1 + \frac{\partial E(w_{it})}{\partial p_{it}} \frac{p_{it}}{E(w_{it})} = -1 + \frac{\Phi_i(\bullet) \times \left[\gamma_{ii} - \beta_i w_i^0\right] - \frac{1}{2}\left[\phi_i(\bullet) \times \sqrt{\sigma_i^2 \exp\left(z_{it}^{'} \xi_i\right)} \times \xi_i \times w_i^0\right]}{E(w_{it})}$$

$$e_{ijt} = \frac{\partial E(w_{it})}{\partial p_{it}} \frac{p_{it}}{E(w_{it})} = \frac{\Phi_i(\bullet) \times \left[\gamma_{ij} - \beta_i w_j^0\right] - \frac{1}{2}\left[\phi_i(\bullet) \times \sqrt{\sigma_i^2 \exp\left(z'_{ht}\xi_i\right)} \times \xi_i \times w_j^0\right]}{E(w_{it})} \quad (13)$$

$$\text{where} \quad E_{it} = 1 + \frac{\left[\beta_i \times \Phi_i(\bullet)\right] + \frac{1}{2}\left[\phi_i(\bullet)\xi_i \sqrt{\sigma_i^2 \exp\left(z'_{ht}\xi_i\right)}\right]}{E(w_{it})}$$

The mean of elasticities over time are provided in the results section.

$$e_{ij} = \frac{1}{T}\sum_{t=1}^{T} e_{ijt}$$

Unconditional (on expenditure) elasticities are computed following Carpentier and Guyomard (2001). The relationships between second-stage (i.e., conditional) and first-stage (i.e., unconditional) expenditure and price elasticities are established under the assumptions of weakly separable direct utility function and the approximate independence of the true cost of living indices with respect to sub-utility levels. Carpentier and Guyomard provide formulas with two-stage budgeting application, but the results are generalized to the three-stage budgeting application following Edgerton (1997).

V. Welfare Analysis

The total effect on consumers' welfare can be evaluated through compensating variation, which is the difference in consumers' expenditure function before and after the introduction of organic products holding utility constant at the post-introduction level:

$$CV = e(p_1, p_N, r, u_1) - e(p_0, p_N^*(p_0), r, u_1) \quad (14)$$

where p_1 is the vector of post-introduction prices of existing products, p_N is the post-introduction price of the new product, r is a vector of prices of outside industry, and u_1 is the post-introduction utility level. The function $p_N^*(p)$ defines the 'virtual' price for the new product, which is the reservation price where demand for the new product would be zero given the prices of other products. Following Hausman and Leonard (2002), this total benefit can be broken into two parts:

$$(15)\quad CV = [e(p_1, p_N, r, u_1) - e(p_1, p_N^*(p_1), r, u_1)] + [e(p_1, p_N^*(p_1), r, u_1) - e(p_0, p_N^*(p_0), r, u_1)]$$

and written as $\mathrm{CV} = -(\mathrm{VE} + \mathrm{PE})$. The first term, variety effect (VE), represents the increase in consumer welfare due to the availability of the new products, holding the existing product prices constant at the post-introduction level. This effect not only captures the benefits from having more options but also the benefits from the new characteristics of new products. The second term, price effect (PE), represents the change of consumer welfare due to the change in the prices of existing products. The introduction of new products can lead the prices of existing products to increase or decrease depending on the competitive structure of the industry. If the new products closely compete with the existing products produced by the same manufacturer, the prices of existing products may rise. However, if the products compete closely with the existing products from different manufacturers, the prices of existing products are likely to decrease.

Price changes from the organic milk introduction are predicted at the group commodity level and the whole benefits in dollar values are measured at the aggregate level of milk industry using the price index of whole market. First, virtual prices can be evaluated at the group commodity level by solving a system of second level demand equations that would set the organic group commodities' shares to zero. There are 6 organic commodity groups among the total 16 commodity groups in this application. Given the virtual prices, variety effect can be calculated as follows:

$$(16)\quad VE = [e(p_1, p_N, r, u_1) - e(p_1, p_N^*(p_1), r, u_1)]$$

Hausman (1981) derives straightforward expressions for expenditure functions from uncompensated demand estimates in some special cases such as linear demand or log linear demand equations. First, he simplifies Roy's identity using the implicit function theorem.

The simplified expression can be integrated out and the indirect utility function can be obtained in a closed form by solving an ordinary differential equation. Finally, the corresponding expenditure function is obtained through inverting the indirect utility function. An explicit expression for the variety effect can be derived in case of a double log demand equation at the top level equation:

$$(17) \quad VE = [\frac{1-\beta_1}{(1+\beta_2)y_1^{\beta_1}}\Big(P\big(p_1, p_N^*(p_1)\big)\, exp\,\Big(\delta_0 + \beta_2 lnP\big(p_1, p_N^*(p_1)\big)\Big) - X_1\Big) + y_1^{1-\beta_1}]^{\frac{1}{1-\beta_1}} - y_1$$

where p_1 and p_N^* represent the post-introduction price indices for non organic commodity groups and the virtual price indices for organic commodity groups, respectively. Function P(·) defines the virtual price index of the milk industry in this region. β_1 is the coefficient on log personal disposable income, β_2 is the coefficient on the milk price index from the top level equation, and δ_0 captures the remainder of the variables in the top level equation. y_1 is post introduction personal disposable income and X_1 is actual milk expenditure.

Hausman provides two different methodologies to estimate price effects. First, one can estimate the price effect directly from the data using OLS methodology if both the pre- and post-introduction consumption data for the existing goods are available. Second, one can estimate the price effects indirectly by solving the equilibrium conditions for the assumed model of competition for the post-introduction world. The price effects in this study are estimated with the direct estimation method because the interest of this study is on measuring the realized benefits without imposing any restrictions. The price effects are estimated with the following equation:

$$(18) \quad logp_{it} = \alpha_i + W_t + I_{it}\delta + \varepsilon_{it}$$

The dependant variable is the log price of the existing conventional milk of type i in time t. The variables α_i and W_t are fixed effects for group i and time t. The regression is conducted separately for log of price of each group and the variable α_i is defined as intercept. W_t are defined with dummy variables for each month. Although it is not clear if 2004 is the year when organic milk is introduced in this market or when data stared being recorded, the point of introduction is assumed to be 2004. For the price effect, the dataset is extended to 4 year periods. There are 48 months in the data and 47 dummies are included in the regression. I_{it} is a post-introduction indicator. I_{it} equal one if the organic milk is introduced. The coefficient δ measures the amount of price change of existing milk after the organic milk introduction[5].

The overall effect of the organic milk introduction on consumer welfare is the sum of the variety effect and the price effect. Hausman (1981) derived the Compensating Variation in the same way he derived the Variety Effect:

$$(19) \quad CV = [\frac{1-\beta_1}{(1+\beta_2)y_1^{\beta_1}}\left(P(p_0, p_N^*)\, exp\left(\delta_0 + \beta_2 lnP(p_0, p_N^*)\right) - X_1\right) + y_1^{1-\beta_1}]^{\frac{1}{1-\beta_1}} - y_1$$

where $\mathrm{P}(\mathrm{p}_0, \mathrm{p}_\mathrm{N}^*)$ is the milk price index evaluated at the pre-introduction prices for the existing (conventional) milks and the virtual prices for organic types of milk.

VI. Results

1) Elasticity Estimates

I applied the econometric approach outlined above to the A.C. Nielsen Homescan data to estimate the system of milk demand equations. The estimates of equation (3), top level demand function, directly give the own price elasticity and the income elasticity, which are -0.2 and 0.88, respectively, in the RDU market. The milk price index in this market is calculated with the given data, the regional disposable income is indirectly obtained from Bureau of Economic Analysis (BEA) and Bureau of Labor Statistics (BLS).

Elasticity estimates for the second stage demand system are provided from Table I-6 to Table I-7. The second stage demand equations are estimated both with and without the variables that account for time trend. The results partly conflict, but overall implications are not different between two models. Thus, the results with time trends are discussed in this

[5] The indicator variable equals one after 2004 because consumers in this region began to purchase organic milk since 2004 according to the data. Although organic milk was available nationwide before 2004 and surely in this region, consumers' perception on organic milk seems to start from 2004 in this region. Thus, we assume the starting point of organic milk introduction as January 2004.

section because the model shows better fits. The value of minimization objective function is smaller and the number of significant estimates at 10% level is larger for the model with time trends. Table I-6 and Table I-7 show conditional and unconditional elasticity estimates, respectively. The elasticities are estimated at the mean of variables. Statistical significances are tested for the conditional elasticity and 108 estimates out of 272 are statistically significant at 10% level. The estimates are very similar between conditional and unconditional elasticities. Thus, the analysis provided below is based on the conditional elasticities because the significance tests are conducted for the conditional elasticities.[6]

All types of milk, except the organic-flavored soy/lactose free milk, show negative own price elasticities. Although the organic-flavored soy/lactose free milk has positive own price elasticity, it cannot be considered as Giffen goods because the estimate is not statistically significant. Cross price elasticities do not show a general pattern, but some implications can be drawn from the results. First, cross price elasticities between organic and conventional milk with same fat contents and flavor do not show a general pattern of substitution between organic and conventional milk. 1% fat unflavored organic and conventional milk have positive cross price elasticities (17.60 and 0.22) implying they are substitutes for each other, whereas organic and conventional unflavored whole milk have negative cross price elasticities (-9.92 and -0.11) suggesting that they are complements to each other. 2% fat milk and soy/lactose-free milk also have negative cross price elasticities between organic and conventional although they are not statistically significant. It is notable that the magnitude of substitution is not symmetric implying that the amount of organic milk consumption change when the conventional milk price changes is larger than the amount of conventional milk change when the organic milk price changes. Second, cross price elasticities show possible substitution patterns between fat contents although it is hard to conclude that similar fat contents are always substitutes with one another. Within the group of conventional unflavored milk, cross price elasticities show pretty clear substitutability

[6] Statistical significances are tested only for conditional elasticities because the test is computationally demanding for unconditional elasticities and the estimates between two elasticities are not significantly different. Tests for unconditional elasticities can be done upon request.

between similar fat contents. Fat free and low fat milk have significant positive cross price elasticities and reduced fat and whole milk also have positive cross price elasticities suggesting that they are substitutes. Low fat and reduced fat milk also show substitutability although their cross price elasticities are not significant and their magnitudes are very small. The results also imply that soy/lactose free milk is substitutable with fat free milk while it is not substitutable with other types of cow milk. Within the group of organic unflavored milk, however, elasticities imply that low fat, reduced fat and whole milk are substitutes for one another although they are not statistically significant according to the conditional elasticity esimates. Soy/lactose free milk and 2% fat milk are substitutes with each other within this group. Cross price elasticities within the group of flavored conventional milk show the similar substitution pattern as in the unflavored organic milk group. Therefore, based on the analysis above, this study carefully concludes that organic milk and conventional milk are neither substitute nor complements to each other, but this study rather concludes that milk with similar fat contents are more substitutable to each other. Further, substitution patterns between conventional and organic milk found in the previous aggregate level studies (Dhar and Flotz 2005) might be driven by the substitutability among fat contents rather than by organic factor.

Elasticity estimates at the brand level are partly provided in Table I-8. An implication can be found between private labeled milk and brand milk products. Private labeled milk products (labeled as alphabet B in Table I-8) are substitutes for the other brand milk products in the same group while brand milk products are not substitutes for private labeled milk most of the case.

2) Variety Effects

Virtual prices of organic milk products are computed solving a system of equations by setting quantities of organic milk to zero as described in section V and the results are summarized in Table I-9. The changes in the virtual prices of each type of organic milk are not consistent with the own price elasticity estimates because the virtual prices resulted from simultaneous effect of organic milk introduction. Virtual price index of milk industry is computed at the original equilibrium. In other words, the index is computed with the mean values of market shares from post-introduction data. Although the differences between actual prices and virtual prices of each type of milk are large, the difference in the milk market index is small because the market share of organic milk is as small as 2.5% on average.

The variety effect is calculated with the formula given in section V which takes the curvatures of demand equations into account. The results imply that consumers in this data set obtain 838.8 dollars per month in total by having organic options in their choice sets and this is 8.2 percent of the milk expenditure. The benefit a representative consumer receives whenever he/she purchases a gallon of milk is 31 cents.

3) Price Effects

The coefficient estimates of equation (11) are presented in Table I-10. The estimates show that the majority of prices of existing conventional milks have increased after the introduction of organic milk even though the magnitudes of increments are very small, ranging from 0.05% to 0.17%. However, the prices have decreased in the cases of 2% and whole fat unflavored milk and soy/lactose free flavored milk. It is hard to draw a generalized conclusion on the price effect of the competition structure of this market from the results because 1) the estimated price effects are very small and the standard errors are relatively large; 2) the directions of price effects conflict with each other; and 3) this model does not capture the supply shock that occurred in 2004. There was a price increase of conventional milk in the middle of 2004 due to the shortage of raw milk production in the U.S., but this model cannot capture the supply shock because the periods of two events coincide. However, ignoring some of the imperfect aspects of the model, this study carefully reaches two possible conclusions on the competition effect, equivalently the price effect. First, competition is structured between the new and the existing products from the same manufacturers. The positive estimates of competitive effects imply cannibalization which is the case that the new product is manufactured by the incumbents so that the prices of existing products are increased. This is also supported by the fact that conventional supermarkets began manufacturing organic milk with their own labels around this time and one of two leading organic milk distributors, Horizon Organic, merged with a conventional dairy distributor, Dean Food, in 2004. Therefore, the coefficient of indicator valued one after 2004 might represent the competition between conventional and organic milk within the same manufacturers. Second, some of the negative price effects for the milk with higher fat contents can be explained by the demand shocks caused by consumers' health concerns on fat contents. Health related concerns on fat contents would cause positive demand shock in lower fat milk market and negative shock in higher fat milk market. The positive shock in lower fat market would lead to the price increase in the lower fat market and the negative shock would result in a lower price in the higher fat milk market.

Finally, the overall effect on consumer welfare of the organic milk introduction is calculated with the formula shown in section V. Since the variety effects and the price effects have opposite directions in this study, the estimates for compensating variation vary depending on the time and duration included in the computation.

VII. Conclusions

The objective of this study is to investigate consumers' welfare improvement from organic milk introduction. In order to obtain the welfare numbers, demands for milk products are estimated adopting the multistage demand system approach. Unlike the previous studies on organic milk demand, this study finds that organic milk and conventional milk are either substitutes or complements to each other. Rather, this study suggests that milk products with similar fat content are more substitutable with one another. Welfare effects are estimated separately by variety effects and price effects. The variety effects indicate that the total amount of benefits consumers obtain by having organic option is about 8% of the milk expenditure. The price effects show the evidence of cannibalization. Although consumers' benefit is significant in terms of variety effects, the overall compensating variation is not significant because the price effects have the opposite direction due to the competitive structure of this market.

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Table I- 1 Distributions of Observed Household Attributes in the US

Income	%	Family Size	%
Under $5000	0.82	Single Member	25.35
$5,000 - $7,999	1.26	Two	37.99
$8,000 - $9,999	1.12	Three	15.03
$10,000 - $11,999	1.65	Four	13.17
$12,000 - $14,999	2.95	Five	5.55
$15,000 - $19,999	5.39	Six	1.93
$20,000 - $24,999	7.67	Seven	0.6
$25,000 - $29,999	6.74	Eight	0.26
$30,000 - $34,999	7.89	Nine+ Members	0.13
$35,000 - $39,999	6.92		
$40,000 - $44,999	6.83		
$45,000 - $49,999	6.39		
$50,000 - $59,999	11.03		
$60,000 - $69,999	8.86		
$70,000 - $99,999	15.17		
$100,000 & Over	9.29		

Table I-1 Continued

Age	%	Age of Child	%
Under 25 Years	0.48	Under 6 only	3.78
25-29	2.9	6-12 only	6.32
30-34	6.33	13-17 only	8.11
35-39	8.95	Under 6 & 6-12	3.32
40-44	12.13	Under 6 & 13-17	0.55
45-49	13.73	6-12 & 13-17	4.3
50-54	13.18	Under 6 & 6-12 & 13-17	0.88
55-64	21.48	No Children Under 18	72.74
65+	20.83		
Employment	**%**	**Education**	**%**
Not Employed or Part-time employed	37.78	Less than College	30.2
Full-time Employed	62.22	College and Post College	69.8

Table I- 2 Market Shares of Organic and Non-organic Milk by Observed Demographic Attributes at the National Level

Income	Organic	Conventional	Family Size	Organic	Conventional
Under $5000	0.6	99.4	Single Member	4.6	95.4
$5,000 - $7,999	2.5	97.5	Two	2.9	97.1
$8,000 - $9,999	4.6	95.4	Three	1.9	98.1
$10,000 - $11,999	4.6	95.4	Four	2.3	97.7
$12,000 - $14,999	0.6	99.4	Five	1.7	98.3
$15,000 - $19,999	2.8	97.2	Six	0.6	99.4
$20,000 - $24,999	2.6	97.4	Seven	0.1	99.9
$25,000 - $29,999	1.7	98.3	Eight	0	100
$30,000 - $34,999	0.9	99.1	Nine+ Members	0	100
$35,000 - $39,999	3.1	96.9			
$40,000 - $44,999	3.3	96.7			
$45,000 - $49,999	2.3	97.7			
$50,000 - $59,999	3.6	96.4			
$60,000 - $69,999	1.7	98.3			
$70,000 - $99,999	2.6	97.4			
100,000 & Over	5.6	94.5			

Table I- 3 Continued

Age	Organic	Conventional	Age of Child	Organic	Conventional
Under 25 Years	0.3	99.8	Under 6 only	2.7	97.3
25-29	3.6	96.4	6-12 only	1.9	98.1
30-34	1.9	98.1	13-17 only	1	99
35-39	3	97	Under 6 & 6-12	3.7	96.3
40-44	2.8	97.2	Under 6 & 13-17	15.2	84.8
45-49	1.9	98.1	6-12 & 13-17	2.2	97.8
50-54	3.5	96.5	Under 6 & 6-12 & 13-17	0.4	99.6
55-64	3	97	No Children Under 18	2.9	97.1
65+	2.6	97.4			
Employment	Organic	Conventional	Education	Organic	Conventional
Not Employed or Part-time	2.8	97.2	Less than College	1.3	98.7
Full-time	2.7	97.3	College and Post College	3.4	96.6

Table I- 4 Market Shares by Fat Contents and Organic Claim in the US

	2002	2003	2004	2005
Non-Fat	23.89	24.03	24.51	27.63
1% Low Fat	16.92	17.05	18.17	20.06
2% Reduced	35.19	34.68	35.80	29.51
Whole Milk	21.41	20.78	18.28	19.00
Soy & Lactose Free	2.59	3.46	3.25	3.80
Non-Organic	98.38	97.75	97.81	97.53
Organic	1.62	2.25	2.19	2.47

Table I- 5 Market Share by Fat Contents and Organic Claim in RDU

	2004	2005
Non-Fat	24.7	27.19
1% Low Fat	15.2	15.38
2% Reduced	30.62	28.38
Whole Milk	25.4	24.44
Soy & Lactose Free	4.08	4.61
Non-Organic	97.5	97.23
Organic	2.5	2.77

Table I- 6 Summary of Commodity Groups in RDU

Group	Fat	Organic	Flavor	Share	Average Price per Fluid Oz	Number of Brands
1	Non-Fat	Nonorganic	No flavor	24.59	0.028274	3
2	1% Low Fat	Nonorganic	No flavor	14.66	0.028336	3
3	2% Reduced	Nonorganic	No flavor	28.59	0.029892	5
4	Whole Milk	Nonorganic	No flavor	24.82	0.031272	7
5	Soy & Lactose Free	Nonorganic	No flavor	1.67	0.048348	5
6	Non-Fat	Organic	No flavor	0.18	0.051564	3
7	1% Low Fat	Organic	No flavor	0.12	0.048173	2
8	2% Reduced	Organic	No flavor	0.14	0.052778	3
9	Whole Milk	Organic	No flavor	0.13	0.052442	4
10	Soy & Lactose Free	Organic	No flavor	0.84	0.046248	3
11	Non-Fat	Nonorganic	Flavored	0.26	0.050497	2
12	1% Low Fat	Nonorganic	Flavored	0.3	0.037342	2
13	2% Reduced	Nonorganic	Flavored	0.6	0.054402	4
14	Whole Milk	Nonorganic	Flavored	1.21	0.047216	5
15	Soy & Lactose Free	Nonorganic	Flavored	0.56	0.041551	4
16	Non-Fat	Organic	Flavored	0	n.a.	0
17	1% Low Fat	Organic	Flavored	0	n.a.	0
18	2% Reduced	Organic	Flavored	0	n.a.	0
19	Whole Milk	Organic	Flavored	0	n.a.	0
20	Soy & Lactose Free	Organic	Flavored	1.32	0.045765	3

Table I- 7 Conditional Elasticities at the Group Level with Time Trend

Group	expenditure	Fat-free	1% fat	2% fat	whole	Soy lactaid	F-F orgnc	1% orgnc	2% orgnc	Whole orgnc	Soy LF orgnc	F-F flavor	1% flavor	2% flavor	Whole flavor	Soy LF flavor	Soy LF org fl
Fat-free	1.13*	-1.81*	1.52*	-0.5	-0.51	0.57*	0	-0.14*	0.03	0.01	-0.03	0.14*	-0.02	-0.1	0.13	-0.07	-0.36*
1% fat	0.98*	2.50*	-2.24*	0.66	-1.38*	-0.53*	0.03	0.22*	0.19*	-0.27*	0.24*	0.01	0.05	-0.14	-0.56*	0.23*	0
2% fat	1.11*	-0.41	0.32	-2.71*	1.71*	-0.24	-0.05	-0.19*	-0.02	0.19*	-0.15	0.07	-0.02	0.11	0.30*	0	-0.01
Whole	0.75*	-0.41	-0.79*	2.07*	-1.36*	-0.08	-0.09	0.13*	-0.04	-0.11*	0	-0.14*	0	-0.02	-0.22*	-0.08	0.38*
Soy LF	1.03*	4.42*	-2.52*	-2.23	-0.66	-1.43	1.29*	0.50*	-0.42*	0.52*	-0.45	-0.52*	0.19	0.31	0.28	0.28	-0.57
F-F orgnc	0.98*	0.04	1.1	-3.74	-6.3	11.61*	-4.08*	-2.67*	-0.2	1.04	-3.22*	1.51	2.32*	-0.1	2.65	0.12	-1.07
1% orgnc	1.16	-18.74*	17.60*	-30.28*	17.24*	8.36*	-4.98*	-7.34*	1.46	1.58	-3.86	2.91*	0.71	-4.04*	14.35*	1.72	2.16
2% orgnc	1.13	2.15	9.49*	-2	-3.45	-4.44*	-0.24	0.93	-1.00*	0.67	4.07*	-1.17	-1.24*	0.82	-4.43*	-1.88	0.58
Whole orgnc	0.6	1.14	-13.97*	19.22*	-9.92*	5.65*	1.27	1.03	0.69	-1.91	-0.26	-1.5	0.93	-0.43	0.73	-0.3	-2.98
Soy LF orgnc	1.14	-0.44	2.41	-2.98	-0.1	-0.95	-0.75*	-0.48	0.80*	-0.05	-1.11*	1.09*	0.38*	-0.13	0.63	0.53*	0.01
F-F flavor	1.14*	8.08*	0.33	4.69	-8.28*	-3.77*	1.22	1.26*	-0.79	-0.99	3.74*	-3.26*	-0.51	0.36	-1.23	-1.79*	-0.2
1% fla	-0.13*	-1.61	3.47	-2.54	0.11	2.55	3.46*	0.57	-1.54*	1.13	2.42*	-0.93	-1.38*	0.78	-4.74*	-0.07	-1.54
2% fla	1.10*	-2.15	-1.96	2.9	-0.53	0.89	-0.03	-0.70*	0.22	-0.11	-0.17	0.14	0.17	-1.00*	1.60*	-0.21	-0.14
Whole flavor	1.49*	1.44	-4.26*	4.34*	-2.98*	0.42	0.46	1.35*	-0.65*	0.1	0.47	-0.27	-0.56*	0.86*	-2.53*	0.42	-0.11
Soy LF flv	0.43*	-1.93	4.30*	0.04	-2.43	1.09	0.05	0.4	-0.68	-0.1	0.99*	-0.95*	-0.02	-0.28	1.05	-1.78*	-0.19
Soy LF org fl	0.78*	-4.60*	0.04	-0.03	5.18*	-0.95	-0.2	0.22	0.09	-0.46	0.01	-0.05	-0.2	-0.08	-0.1	-0.08	0.43

Table I- 8 Unconditional Elasticities with time trend

Group	expenditure	Fat-free	1% fat	2% fat	whole	Soy lactaid	F-F orgnc	1% orgnc	2% orgnc	Whole orgnc	Soy LF orgnc	F-F flavor	1% flavor	2% flavor	Whole flavor	Soy LF flavor	Soy LF org fl
Fat-free	0.99	-1.61	1.65	-0.25	-0.28	0.59	0	-0.14	0.03	0.01	-0.01	0.15	-0.02	-0.09	0.14	-0.06	-0.34
1% fat	0.86	2.68	-2.12	0.87	-1.19	-0.5	0.03	0.22	0.19	-0.27	0.25	0.01	0.05	-0.13	-0.54	0.23	0.02
2% fat	0.98	-0.21	0.45	-2.47	1.93	-0.22	-0.04	-0.19	-0.02	0.19	-0.14	0.07	-0.02	0.12	0.32	0	0.01
Whole	0.66	-0.27	-0.7	2.23	-1.21	-0.06	-0.08	0.13	-0.04	-0.11	0.01	-0.14	0	-0.01	-0.21	-0.08	0.39
Soy LF	0.91	4.6	-2.4	-2.01	-0.45	-1.41	1.29	0.5	-0.41	0.52	-0.44	-0.52	0.19	0.32	0.29	0.28	-0.55
F-F orgnc	0.86	0.21	1.21	-3.53	-6.1	11.63	-4.08	-2.67	-0.2	1.05	-3.21	1.52	2.32	-0.09	2.66	0.13	-1.05
1% orgnc	1.02	-18.53	17.73	-30.03	17.47	8.39	-4.97	-7.34	1.46	1.58	-3.85	2.91	0.72	-4.03	14.36	1.73	2.18
2% orgnc	0.99	2.35	9.62	-1.76	-3.22	-4.41	-0.24	0.93	-1	0.67	4.08	-1.16	-1.23	0.83	-4.42	-1.87	0.6
Whole orgnc	0.53	1.24	-13.9	19.34	-9.79	5.67	1.27	1.03	0.69	-1.91	-0.25	-1.5	0.93	-0.42	0.74	-0.29	-2.97
Soy LF orgnc	1	-0.24	2.54	-2.73	0.14	-0.92	-0.75	-0.48	0.8	-0.05	-1.1	1.09	0.38	-0.12	0.65	0.54	0.03
F-F flavor	1	8.28	0.46	4.94	-8.05	-3.74	1.22	1.26	-0.79	-0.99	3.75	-3.26	-0.5	0.36	-1.21	-1.78	-0.18
1% fla	-0.11	-1.63	3.46	-2.57	0.08	2.54	3.46	0.57	-1.54	1.13	2.41	-0.93	-1.38	0.78	-4.74	-0.07	-1.54
2% fla	0.97	-1.96	-1.83	3.14	-0.31	0.91	-0.03	-0.7	0.23	-0.11	-0.16	0.15	0.17	-0.99	1.62	-0.21	-0.13
Whole flavor	1.31	1.71	-4.09	4.66	-2.68	0.45	0.47	1.35	-0.65	0.11	0.48	-0.26	-0.56	0.88	-2.51	0.43	-0.09
Soy LF flv	0.38	-1.85	4.35	0.13	-2.35	1.1	0.06	0.4	-0.68	-0.1	0.99	-0.95	-0.02	-0.28	1.06	-1.78	-0.18
Soy LF org fl	0.69	-4.46	0.13	0.14	5.33	-0.94	-0.2	0.22	0.09	-0.46	0.02	-0.04	-0.2	-0.07	-0.09	-0.08	0.44

Table I- 9 Unconditional Elasticities at the Brand Level

	Income	1_A	1_B	1_C	2_A	2_B	2_C	3_A	3_B	3_D	3_C	3_E
1_A	0.94	-2.02	0.92	-0.14	0.09	1.44	0.03	-0.01	-0.21	0.00	-0.01	0.00
1_B	0.76	0.66	-1.86	0.21	0.07	1.16	0.03	-0.01	-0.17	0.00	-0.01	0.00
1_C	0.99	-0.07	-0.16	-1.07	0.09	1.52	0.04	-0.01	-0.23	0.00	-0.01	0.00
2_A	2.02	0.40	4.23	0.18	-1.24	-3.65	-0.09	0.09	1.82	0.04	0.08	0.02
2_B	0.84	0.17	1.75	0.07	-0.06	-2.13	0.13	0.04	0.75	0.02	0.03	0.01
2_C	0.87	0.17	1.81	0.08	-0.10	-0.92	-1.12	0.04	0.78	0.02	0.03	0.01
3_A	0.98	-0.01	-0.20	-0.01	0.03	0.41	0.01	-1.74	-0.57	-0.03	-0.10	-0.05
3_B	0.98	-0.01	-0.20	-0.01	0.03	0.41	0.01	0.78	-3.98	0.31	0.27	0.13
3_D	1.38	-0.02	-0.28	-0.01	0.04	0.58	0.01	-0.12	-1.84	-1.41	-0.22	0.07
3_C	1.01	-0.01	-0.20	-0.01	0.03	0.43	0.01	0.00	-1.98	0.14	-0.82	-0.94
3_E	0.97	-0.01	-0.19	-0.01	0.03	0.41	0.01	-0.08	-1.27	-0.01	-0.07	-1.05

	Income	4_A	2_B	4_F	4_D	4_G	4_C	4_E	5_B	5_H	5_I	5_J	5_K
4_A	0.64	-1.40	0.44	0.04	0.01	-0.14	-0.12	-0.05	-0.02	-0.04	-0.01	-0.01	-0.01
2_B	0.70	0.37	-2.12	-0.05	0.18	0.01	0.28	-0.03	-0.02	-0.05	-0.01	-0.01	-0.01
4_F	0.66	-0.04	-0.15	-0.68	-0.14	-0.13	-0.07	-0.06	-0.02	-0.04	-0.01	-0.01	-0.01
4_D	0.68	-0.02	-0.56	-0.13	-0.78	0.14	0.05	-0.01	-0.02	-0.04	-0.01	-0.01	-0.01
4_G	0.71	0.03	-2.11	-0.13	0.08	-1.15	-0.18	-0.10	-0.02	-0.05	-0.01	-0.01	-0.01
4_C	0.69	-0.05	-0.09	0.02	-0.04	-0.02	-1.16	-0.02	-0.02	-0.04	-0.01	-0.01	-0.01
4_E	0.66	-0.02	-0.24	0.01	0.00	0.01	-0.03	-1.00	-0.02	-0.04	-0.01	-0.01	-0.01
5_B	2.44	-0.04	-1.04	-0.01	-0.03	-0.05	-0.09	-0.02	-2.52	-2.50	-0.47	-0.94	-0.82
5_H	1.29	-0.02	-0.55	-0.01	-0.01	-0.03	-0.05	-0.01	-0.48	-2.26	-0.36	-0.45	-0.28
5_I	2.45	-0.04	-1.05	-0.01	-0.03	-0.05	-0.09	-0.02	-1.53	-2.51	-1.48	-0.94	-0.82
5_J	2.46	-0.04	-1.05	-0.01	-0.03	-0.05	-0.09	-0.02	-1.54	-2.53	-0.48	-1.95	-1.82
5_K	2.42	-0.04	-1.04	-0.01	-0.03	-0.05	-0.09	-0.02	-1.51	-2.48	-0.47	-0.93	-1.81

*** Numbers represent groups and Alphabets represent brands; Alphabet B represents supermarket labels.

Table I- 10 Variety Effects

Actual Price Index (per floz)	Virtual Price Index (per floz)	Additional Consumer Welfare (VE, per month in this region)	Benefits per gallon purchase	% of Milk Expenditure
0.029	0.031	838.8	0.31	8.2

Table I- 11 Price Effects

Group	Post-Introduction	Intercept	R-squared
Fat Free Unflavored Non-Organic	0.08 % (0.20%)	-3.74 % (0.14%)	0.30
1% Fat Unflavored Non-Organic	0.05 % (0.14%)	-3.75 % (0.10%)	0.23
2% Fat Unflavored Non-Organic	-0.17 % (0.16%)	-3.47 % (0.12%)	0.10
Whole Fat Unflavored Non-Organic	-0.09 % (0.14%)	-3.38 % (0.10%)	0.13
Soy/Lactose Free Unflavored Non-Organic	0.10 % (0.11%)	-3.29 % (0.08%)	0.08
Fat Free Flavored Non-Organic	0.13 % (0.18%)	-3.12 % (0.13%)	0.57
1% Fat Flavored Non-Organic	0.17 % (0.42%)	-3.40 % (0.30%)	0.15
2% Fat Flavored Non-Organic	0.06 % (0.21%)	-3.08 % (0.15%)	0.20
Whole Fat Flavored Non-Organic	0.10 % (0.13%)	-3.05 % (0.09%)	0.21
Soy/Lactose Free Flavored Non-Organic	-0.08 % (0.29%)	-3.07 % (0.20%)	0.09

CHAPTER 2

Household Level Welfare Effect of Organic Milk Introduction

I. Introduction

Firms have been seeking market power by constantly differentiating their products from competitors. Firms can make more profits associated with first movers' advantage by introducing new products which are similar but not identical to the other products. Consumers also benefit from quality improvements, facing more choices and lower prices driven by enhanced competition in the market. How much consumers benefit from the new products and how much money consumers are willing to pay for quality improvement, or additional characteristics of the new good, are important economic questions to firms that formulate innovation and competition policy and to policy makers who regulate the market. Information on which consumers benefit most from the new product will give more complete information for the decision-making procedure.

Although new product introduction is more frequent in high tech industries, recent innovations in the agricultural industry also make new products, such as Genetically Modified (GM) food and Organic food, available to consumers. While various opinions on the effect of GM food products are not in agreement among nutrition experts, consumers' concern on health and environment increase demand for organic food products. As part of the organic food market, the organic milk market has also been growing. According to the United States Department of Agriculture (USDA), organic cow milk and soy milk drinks are the top two categories among processed organic products next to fresh products. Many studies analyze the demand for organic milk in various contexts in a timely manner, but very few studies are done in the context of welfare effects. To my knowledge, Dhar and Foltz (2005) is the only paper that analyzes the demand for organic milk in the context of its welfare impacts. They estimate the demand for milk and the welfare effect of specialty milk at the industry level categorizing milk products into three segments: recombinant bovine growth hormone (rBST) free labeled milk, organic labeled milk, and unlabeled (conventional) milk. The main weakness of their study is that their model does not take consumers' heterogeneous tastes into account. The absence of taste variables might lead to inaccurate estimates of welfare effects because the expected utility accounted for by taste variables will fall into the idiosyncratic error terms which will not be accounted in the welfare computation.

Therefore, this study analyzes demand for milk at the disaggregated level of the industry, i.e., individual households' demand for milk products at the brand level. The demand model is specified at the individual household level to account for heterogeneous consumer behavior. The demand parameters are estimated at the Universal Product Code (UPC) level to accommodate product characteristics and consumer preferences. The random coefficient (or Mixed) logit approach is employed to incorporate observed and unobserved heterogeneous consumer tastes. The welfare effects of organic milk are also measured for each individual household. As a result, the entire distribution of welfare effects can be obtained and questions like which type of households benefit the most from the introduction of organic milk can be answered.

The results indicate that the age, income and education of the head in each household are associated with the preferences on the different types of milk products. For example, the parameter estimates evidence the preferences for lower fat milk products of households with higher income, higher education or younger head. It is also found that households with higher income or/and higher education value organic milk more than households with lower income or/and lower education do. However, households with elder heads do not value the organic characteristic as much as the ones with younger heads. This study also provides the distribution of welfare effects for the households in the data. The distribution shows similar implications of the parameter estimates.

The literature will be reviewed in section II. Section III and section IV explain the model and the data used, respectively. The estimation results are presented in section V.

II. Literature Review

1) Discrete Choice Models

Different types of discrete choice models are developed in the studies where heterogeneous consumer tastes as well as the quality of products matter. In the discrete choice framework, the rational behavior of heterogeneous consumers is defined such that the consumer is assumed to choose one utility maximizing alternative from a set of choices that are mutually exclusive, exhaustive and finite. The utility an individual receives from choosing one alternative is known to the decision maker, but it is not completely observed by the researcher. Under the Random Utility Maximization (RUM) framework, different types of discrete choice models are derived depending on the distributional assumptions on unobserved component of the utility function.

The logit model can be derived if and only if the error term of RUM is independent and identically distributed and has a type I extreme value (or Gumbel) distribution. McFadden (1984) shows that the logit formula necessarily implies that unobserved utility is distributed extreme value. While the logit model is proven to work well in many applications, the model exhibits the Independence from Irrelevant Alternatives (IIA) property which states that the ratio of purchasing probabilities for any two alternatives does not depend on any alternatives other than the two given alternatives. As pointed out by Chipman (1960) and Debreu (1960), this property is not behaviorally plausible in many cases although it may be realistic in some applications. The weakness of this property is well explained throughout the literature using the famous red bus/ blue bus problem developed by McFadden (1974).

In order to overcome the limitations of IIA property, models with more general dependence on explanatory variables and distributions that permit more general substitution patterns are introduced. For example, Ben-Akiva (1973) and Train et al. (1987) use nested logit models in which the set of alternatives faced by a decision maker can be partitioned into subsets so that IIA does not exist for alternatives in different subsets. However, the application of this model is limited because IIA still holds within each subset/nest, and the model does not explain unobserved preferences on the product characteristics. The probit model is derived by Marschak (1960) under the assumption of joint normal distribution of the error terms. The probit model not only overcomes the IIA property, but also represents random taste variation unlike standard logit or nested logit models. However, the model is restrictive in the sense that it requires normal distributions for all unobserved components of utility and its choice probability does not have a closed form so that the estimation requires exhaustive simulation.

Mixed logit models can be an alternative that is flexible and computationally practical. Defined as a multinomial logit model with random coefficients drawn from cumulative distributions, the mixed logit model accounts for unobserved taste variations and relaxes the IIA property. The underlying mixing distributions can be any parametric family such as multivariate normal or log normal. However, by keeping the idiosyncratic error term as iid extreme value, the model presents some properties of standard logit such that the choice probability has a closed form so that the simulation is relatively simple. In addition, mixed logit can approximate any Random Utility Maximization model under mild regulatory conditions (McFadden and Train 2000), while nested logit cannot represent all RUM consistent behavior and RUM consistent probit model requires special restrictions on covariance structures (McFadden 1981, 1984). Mixed logit approach has been known for many years, but full application with individual consumer tastes was not available until recent years mainly due to the difficulties of simulation and the unavailability of revealed consumer level preference data. In early applications, such as Boyd and Mellman (1980) and Cardell and Dunbar (1980), explanatory variables are invariant over individual households and the dependant variable is market share rather than individual choice. Later, BLP used socioeconomic variables but the choice probabilities are estimated at the market level utilizing aggregate data. Empirical studies at the individual consumer level, Train et al (1987) and Ben-Akiva et al. (1993), are also conducted, but only one or two dimensions of random coefficients are included due to the intensity of computation. Only a few recent papers in recreational cite choices, such as Murdock (2006) and Timmins and Murdock (2007), show the full power of mixed logits[7].

2) Demand for Differentiated Goods and Welfare Studies

Studies on the welfare effects of new product introduction have been conducted in many industries in various contexts from competitive structure of the industry to the true cost of living price index. As the industries become competitive, new product introduction is not an unusual phenomenon and new products are usually in the form of differentiated goods which are closely related but not identical. Accordingly, various methodologies estimating demand for a set of differentiated products are also developed to describe the market in the analysis.

Hausman and Leonard (2002) estimate the benefits to consumers associated with the introduction of a brand of bath tissue product adopting Gorman's multi-stage budgeting approach. Under the assumption of weakly separable preferences, Gorman argues that consumers allocate their income into broad groups of commodities at higher stages of budgeting and more detailed within-group allocation happens at lower levels. Thus, the demand functions at each stage depend only on group expenditure and prices of products within the group. Hausman and Leonard show that one can use this framework to formulate and estimate demand systems of differentiated goods in the Neoclassical demand framework. However, the main limitation of this approach is that it is difficult to apply at the individual household level because one can encounter a lot of zero purchasing observations and the estimation requires the integrals of multivariate probability density function that can be computationally cumbersome. Moreover, the model is somewhat restricted in its ability to accommodate a large number of commodities.

An alternative to the market-level representative agent approach is to incorporate consumer preferences over products as a function of consumer characteristics and product

[7] To my knowledge, this paper is the first application of consumer level mixed logit in milk (food) demand literature.

attributes in a discrete choice framework. There have been many efforts to analyze the demand for differentiated goods that reflects individual preferences in many applications. A few examples that are studied in the context of the welfare effects of new goods are summarized here. Trajtenberg (1989) suggests a discrete choice model with consumer and product attributes to measure the welfare change from computed topography (CT) scanners innovation although the characteristic variables could not be included in the actual estimation due to computational difficulty present at that time. Berry, Levinsohn and Pakes (1995), BLP hereafter, provide techniques to estimate demand and supply for a class of differentiated products which only requires aggregate market-level data on the prices, quantities sold, and characteristics of the products. They incorporate consumer characteristics into the model by drawing pseudo data from Census data. BLP (1993) show that their procedure makes it possible to construct a price index closer to the true cost of living index that accounts for new product introduction with the application to the automobile industry. Petrin (2002) also studies the consumer benefits from the minivan introduction in the automobile industry. He estimates a market-level demand function that accounts for consumer-level heterogeneity in tastes using market-level data on sales and characteristics, with information that relates the average demographics of consumers to the characteristics of the products they purchase. He also finds that models without micro data yield much larger welfare numbers, primarily because the micro data appear to free the model from a heavy dependence on the idiosyncratic logit taste error. Although his method provides more precise estimates of demand when a researcher is constrained to market level data, it cannot substitute for a model incorporating consumer-level data.

One thing noticeable in this literature is that past studies in this area have mostly focused on developing estimation techniques to incorporate consumer taste variations under the constraint that only market level data are available and there are computational difficulties of multi-dimensional integration.

III. The Model

1) Random Utility

In a discrete choice framework, consumers are assumed to purchase one unit among alternatives that gives the maximum utility and ties are assumed to occur with zero probability. For simplicity, this model defines the set of alternatives as one package of different milk products within the cross section. The model does not consider multiple purchases in the same week or multiple trips [8] over the given year mainly to avoid complicated modeling and computations. While these issues[9] can be taken into account as an extension, each purchase is modeled as an independent event because the main concern of this paper is which factor has more of an impact on an individual's choice of milk products rather than how many products (or how often the products) are purchased by an individual. In addition, unlike the products in other industries, dairy products are perishable so that it is not likely that a household would purchase a large number of products in each trip. Thus, the single unit purchase assumption is reasonable although multiple purchases in the same week are still observed from the data[10]. Finally, it is also assumed that the model is conditional on the occasions when the consumers choose a type of milk product from the choice set. The model does not allow the possibility of not buying a milk product and probabilistic demand derived in the following section is conditional on participation in milk consumption. The utility obtained from purchasing a milk product in a Random Utility Maximization (RUM) framework is given by

(1) $$U_{ij} = X_j \beta_i + Z_i X_j \theta + \gamma_i (y_i - p_{ij}) + \omega_j + \varepsilon_{ij},$$

[8] For simplicity in this study, the repeated trips by the same households are considered as the purchases of different households with same demographics taking cross-sectional approach.
[9] Dube (2005) accommodates assortment decisions of soft drink purchase following Hendel's (1999) multiple discreteness model. He derives the expected aggregate demand for each individual household where the consumption points and the shopping points are assumed not to coincide and consumers are assumed to purchase the aggregate amount of consumptions anticipated at the point of shopping.
[10] Detailed numbers are given in the data section.

where X_j is a vector of observable attributes of alternative j; Z_i is a vector of observed attributes of household i; y_i is the income of household i; p_{ij} is the price household i faces in choosing j; β_i and γ_i are random coefficients that capture the preferences randomly varying over consumers; ω_j is unobservable attributes of alternative j; ε_{ij} is an idiosyncratic source of utility for household i at choice j.

Equation (1) implies that the level of utility attained by alternative j is a function of the attributes of the alternative, consumer characteristics, and the economic variables that determine the budget constraint: income and price. p_{ij} is defined as price per gallon and y_i is defined as income allocated to gallon milk purchase. The term $(y_i - p_{ij})$ represents the money left over for household i associated with the purchase of choice j and the coefficient γ_i represents the marginal utility of income. The price varies across items and across individuals because the prices for the same item are different depending on which store the consumer purchased the product and whether he/she used discount coupon or a membership card[11]. The impacts of expenditure purchasing item j, γ_i, are specified to vary over individuals in order to avoid IIA restrictions and the mixing distribution is specified with a lognormal distribution to impose a downward sloping demand curve.

Heterogeneous consumer tastes on the product characteristics are accounted for in the model both systematically and randomly. The systematic (observed) consumer preferences can be captured by the interaction terms of observed consumer characteristics and alternative attributes. θ is a vector of parameters on the interaction terms and it represents the preferences of different types of consumers on the product characteristics. The random (unobserved) consumer preferences can be accounted for by allowing the coefficients of product characteristics to vary across decision makers with density function $f(\beta)$. Thus, the random coefficients β_i capture the remaining taste variations that cannot be explicitly linked with individual's demographic characteristics. Following the convention of mixed logit

[11] Price data are recorded by each consumer with hand-held scanner at home rather than collected from supermarket counter. Different consumers can purchase the same items at different prices depending on which store or branch they purchase at.

applications, $f(\beta)$ is specified with a normal distribution and the random utility can be rewritten as

(2) $$U_{ij} = X_j\bar{\beta} + X_j\sigma u_i + Z_iX_j\theta + \gamma_i(y_i - p_{ij}) + \omega_j + \varepsilon_{ij}$$

where $\bar{\beta}$ and σ are the mean and the standard deviation, respectively, of the normal distribution to be estimated. Observed product characteristics include fat content, organic claim and the package size of milk product. Observed consumer characteristics include family size, the age and education of head and income of the family.

There are additional factors related to the product attributes that are difficult to quantify or unobserved by the researcher but are frequent determinants of demand. These unknown alternative characteristics are captured in ω_j . Including this term is important in the sense that its absence will produce inconsistent parameter estimates. Berry (1994) argues that ignoring the unobserved characteristics will cause severe price endogeneity because the unobserved characteristics which are included in the error term are correlated with price. Murdock (2006) finds that failing to address unobserved characteristics causes welfare estimates for improvements to be biased. Her Monte Carlo simulations show that parameter estimates are less efficient and standard errors are biased.

2) Choice Probabilities

The probability that the household i chooses alternative j can be derived following McFadden (1974).

(3) $$P_{ij} = Prob(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik} \; \forall\, j \neq k)$$

$$= Prob(\varepsilon_{ik} < \varepsilon_{ij} + V_{ij} - V_{ik} \; \forall\, j \neq k)$$

where $V_{ij}(\beta) = X_j\bar{\beta} + X_j\sigma u_i + Z_iX_j\theta - \gamma_i p_{ij} + \omega_j$ and β is a vector of random and fixed coefficients.

Assuming the independently identically distributed extreme values for the idiosyncratic error term, ε_{ij} , the choice probabilities of random coefficient model are the integrals of standard logit probabilities over a density of parameters;

(4) $$P_{ij} = \int L_{ij}(\beta) f(\beta) d\beta,$$

where

$L_{ij} = \frac{\exp\left(V_{ij}(\beta)\right)}{\sum_{k=1}^{J}\exp\left(V_{ik}(\beta)\right)}$ and $f(\beta)$ is the probability density function of mixing distributions.

Given the mixing distributions, the choice probability can be written;

(5) $$P_{ij} = \int \frac{exp\left(V_{ij}(\beta)\right)}{\sum_{k=1}^{J} exp\left(V_{ik}(\beta)\right)} f(\beta|b, W) d\beta$$

where the lognormal density is assigned for $f(\beta|b, W)$ of price coefficient and the normal distribution is assigned for the parameters of other characteristics. b and W are the vectors of mean and covariance to be estimated.

3) Elasticities

Mixed logit does not exhibit independence from irrelevant alternatives (IIA) or the restrictive substitution patterns of logit. The ratio of mixed logit probabilities depends on all the data since the denominators of logit formula are inside the integral so that do not cancel. The own price elasticities of alternative j and the cross price elasticities of alternative j and s for household i are respectively

(6) $$E_{i,jj} = \frac{\partial P_{ij}}{\partial X_{ij}^{m}} \frac{X_{ij}^{m}}{P_{ij}} = X_{ij}^{m} \int \frac{\beta^{m}}{P_{ij}} \frac{exp\left(V_{ij}(\beta)\right)}{\sum_{k=1}^{J} exp\left(V_{ik}(\beta)\right)} \left(1 - \frac{exp\left(V_{ij}(\beta)\right)}{\sum_{k=1}^{J} exp\left(V_{ik}(\beta)\right)}\right) f(\beta)\, d\beta$$

(7) $$E_{i,js} = \frac{\partial P_{ij}}{\partial X_{is}^{m}} \frac{X_{is}^{m}}{P_{ij}} = -X_{is}^{m} \int \frac{\beta^{m}}{P_{ij}} \frac{exp\left(V_{ij}(\beta)\right)}{\sum_{k=1}^{J} exp\left(V_{ik}(\beta)\right)} \frac{exp\left(V_{is}(\beta)\right)}{\sum_{k=1}^{J} exp\left(V_{ik}(\beta)\right)} f(\beta)\, d\beta$$

where β^m is the m-th element of vector β, the coefficient of price, and X_{ij}^{m} is the m-th element of vector X_{ij}, which is the price variable in this model. P_{ij} is the probability that household i chooses alternative j.

4) Welfare Analysis

With the logit assumptions, the consumer surplus associated with a given set of alternatives has a closed form and is easy to calculate. Denote $CS_i = \frac{1}{\alpha_i} \max(U_{ij}\ \forall j)$ as the consumer surplus for household i, where α_i is the marginal utility of income of household i. $\frac{dU_i}{dy_i} = \alpha_i$, with y_i the income of household i. The division by α_i translates utility into dollars. Since the researcher cannot observe U_{ij} but V_{ij}, the researcher is able to calculate the expected consumer surplus as $E(CS_i) = \frac{1}{\alpha_i} \mathrm{E}[\max(V_{ij} + \varepsilon_{ij} \forall j)]$, where the expectation is over all possible values of ε_i. Small and Rosen (1981) shows that, if each error ε_{ij} is i.i.d. type I extreme value and utility is linear in income, the expected consumer surplus can be derived as:

(8) $$E(CS_i) = 1/\alpha_i \ln[\textstyle\sum_{j=1}^{J} \exp(V_{ij})] + C$$

where C is an unknown constant. Therefore, when the choice set for the consumers change from Ω^0 to Ω^1, where the superscripts 0 and 1 denote the observed scenario (post introduction of organic milk) and the counterfactual scenario (without organic choices), respectively, the change in expected consumer welfare for household i is

(9) $$CV_i = \frac{1}{\alpha_i}\left[\ln[\textstyle\sum_{j=1}^{J_1} \exp(V_{ij}^1)] - \ln[\textstyle\sum_{j=1}^{J_0} \exp(V_{ij}^0)]\right],$$

where

$$V_{ij} = X_j\bar{\beta} + X_j\sigma u_i + Z_i X_j \theta - \gamma_i p_{ij} + \omega_j$$

The marginal utility of income α_i is approximated by γ_i in equation (2) for welfare estimation in this study. It is notable that ω_j plays an important role in welfare estimation. If the new product has desirable unobserved characteristics, excluding this term will lead the welfare effects to be underestimated because V_{ij}^{0} will not take the positive characteristics into account. On the other hand, the welfare effects will be overestimated if the undesirable unobserved product characteristics are ignored.

In this paper, the welfare effect will not be measured in a general equilibrium framework. In other words, the prices of non-organic products will be assumed to remain unchanged when organic products are removed from the choice set. Consumers benefit from the new product in two aspects. On one hand, consumers are better off due to the additional option from the new product and different attributes of the new product, which is called the Variety Effect. On the other hand, consumers benefit from the enhanced competition on the supply side because the competition usually lowers the prices of products in the relevant market, which is called the Price Effect. However, the price effect depends on the competitive structure of the market. Consumers face the lower prices when the new product is introduced by entrants, but face higher prices when the new product is introduced by incumbents so that they raise the price of existing goods to market the new product. Compensating variation consists of these two separate effects. This study only measures the variety effect. The Price Effect and total compensating variations will be studied in the extension of this chapter. [12]

IV. Data and Estimation

1) Data

AC Nielsen Homescan panel data are used for the estimation. The sample is selected among volunteers based on both demographic and geographic targets. Stratification is done by AC Nielsen to ensure that the sample matches the U.S. Census. The nationally representative sample consists of purchase histories of milk products at the Universal Product Code (UPC) level including price paid for the item, product characteristics and demographic

[12] Compensating Variation and Price effect will be also estimated in the next chapter incorporating supply side effects. Price changes of existing conventional milk can be obtained (indirectly) by assuming a certain type of market structure of the milk industry or (directly) by extending the time period of data. The next chapter will provide both direct and indirect price effects.

information. The recorded price data for the same item may vary across households depending on the type of outlet, store location or whether the coupon/discount is applied or not. In addition to the characteristics variables, brief descriptions on each UPC are provided so that additional information on the products can be obtained.

For this study, weekly data in 2005 are collected. The unit of the item to be analyzed is defined with UPCs in order to examine the market at a very disaggregated level. UPC is the smallest unit of product that identifies the manufacturer and the category of the item. According to the dataset, there exist approximately 7,000 different UPCs in the nation in 2005. One thing notable about the dairy industry is that the market is fairly localized so that specific brands of milk only appear in specific regions although there exist, of course, some national brands. Thus, focusing on a specific regional market is inevitable in order to analyze milk product at the disaggregate level of industry. Metropolitan areas in North Carolina, which include Raleigh, Durham, Chapel-Hill and Charlotte (RDU hereafter), are chosen for the study. Another thing to note about the dairy industry is that the market is dominated by a few suppliers and supermarket brand products have the largest market shares. Although a specific regional market is selected for the study, there exist 600 UPCs and 86 brands in this market. It is difficult to manage the whole list of UPCs so top items with larger than 0.8% market shares are selected. As a result, this paper analyzes only 39 items defined by the UPCs, and the total market share of these 39 items is about 65% of milk sales. An interesting point is that 34 items out of 39 are private labeled milk products that account for 56%[13] of the market share. In addition, 50 UPCs among the 600 UPCs and 6 brands among the 86 brands fall into the organic category and each of UPCs in organic category takes on average less than 0.1% of the milk market. Thus, the organic products are aggregated across UPCs and considered as one product for the simplicity of estimation[14]. In

[13] The market share for private labeled milk will be even larger if it considers the products not included in 39 items.

[14] Only the organic products in half gallon packages are included in the estimation because the gallon size products take only 0.17% of the market share while the half gallon take about 4% of the market share. Gallon size products are not aggregated with the half gallon because it is considered that the

this way, the welfare analysis does not need to consider path dependence in which the order of introduction of each organic milk product affects the welfare estimate. The aggregate market share of the top selling items and combined organic products is about 70% and organic alone takes 4% of the market share. In order to represent the whole market, an outside good is defined. The rest of the products that account about for 30% of the market are aggregated and considered as one product called the “outside good”. The items in the outside goods are assumed to be homogeneous. The mean values are used for the characteristics variables, but prices are left to vary because they vary across consumers. Therefore, 41 items are considered for the analysis and the individual unit of analysis is the individual household’s probability of choosing each item defined here. A set of price data for the products that household i does not purchase is also created to compute the logit formula defined in equation (4). If the item is purchased by other consumers in the same store of the same region in the same week, the average of the prices sold in the same store of the region in that week is used for the items not purchased by household i. If there is no record of sales for the item in the same store of the region in the same week, the average price of the same store of other regions in the same week is used. Finally, multiple purchases from the same trip are split into multiple shopping trips because this paper assumes each purchase is an independent event. The total number of purchases observed from the data is 38,689 purchases. Table II-1 and Table II-2 show summary statistics of the 41 items considered in the model. Table II-3 summarizes demographic information.

2) Estimation

This section describes the procedure used for estimating the parameters in equation (2). First, the terms in equation (2) that only vary across alternatives are combined into one term following Murdock (2006). The alternative specific constant δ_j represents both observed and unobserved product characteristics as shown in equation (11).

(10) $$U_{ij} = X_j \sigma u_i + Z_i X_j \theta - \gamma_i p_{ij} + \delta_j + \varepsilon_{ij},$$

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prices are affected by package size and combining different size of organic milk might cause different estimation results.

(11) $\delta_j = X_j \bar{\beta} + \omega_j$.

In the first step of the estimation, coefficients in equation (10), along with alternative constants δ_j, are estimated. In the second step, the vector $\bar{\beta}$ in equation (11) can also be estimated by regressing the estimated alternative specific constants from equation (10) on the product characteristics variables with the OLS estimator.

Maximum Simulated Likelihood Estimator (MSLE) is used to estimate the random and fixed coefficients in equation (10). First, the choice probabilities in equation (5), where the expected utility is defined with a full set of alternative specific constants as explained in this section, are approximated by simulation. Random numbers are drawn by Halton[15] sequences and inverted into the numbers drawn from the each distribution[16] assigned for the parameters by the researcher. In each iteration, the logit formula $L_{ij}(\beta^r)$ is calculated with each draw and any given value for the parameters. The simulated probabilities are obtained by averaging the logit formula:

(12) $\breve{P_{ij}} = \frac{1}{R}\sum_{r=1}^{R} L_{ij}(\beta^r)$

where R is the number of draws. Then the simulated probabilities are inserted into the log-likelihood function to find a simulated log-likelihood:

(13) $SLL = \sum_{i=1}^{I}\sum_{j=1}^{J} d_{ij} \ln \breve{P_{ij}}$

where d_{ij} is an indicator variable that has value 1 if individual i chooses alternative j, otherwise 0. The MSLE is the value of parameters that maximizes SLL. The Broyden-

[15] To take a sequence of draws that provides a better approximation to the relevant integral and reduce the variance caused by simulation than a purely random sequence, we draw numbers from the Halton Sequences and then convert those numbers into random numbers from the standard normal distributions (Spanier and Maiz, 1991). The random numbers of 50 draws are used for all the simulations in this study since the estimation results are not sensitive to the number of draws when the model is estimated both with 50 draws and 100 draws.

[16] The taste variations u_i are specified to be drawn from standard normal distribution, and the random parts of the parameter on price are specified to be drawn from log normal distribution with log(mean)=m and log(standard deviation)=s.

Fletcher-Goldfarb-Shanno (BFGS) Quasi-Newton method is used for searching the maximum numerically.

The estimated parameters are used to compute the price elasticities and welfare effects. Both elasticities and welfare numbers are obtained from the simulation. I simulate the integrals in equation (6) and (7) for each household in the same way described above for the simulated probabilities, and compute the elasticities for each household. The median of own and cross price elasticities are reported in the next section. For welfare analysis, the expected consumer surplus for each household is obtained from simulation. First, the marginal utilities of income and the expected utilities are simulated separately in order to take the variations in both terms among the households into account. Then the expected consumer surplus without constant C in equation (8) is computed for each household:

(14) $$E\widetilde{(CS_i^k)} = \frac{1}{R}\sum_{r=1}^{R} E(CS_i^k)^r$$

where $E(CS_i^k)^r = {}^{1}\!/_{\alpha_i^r} \ln[\sum_{j=1}^{J_k} \exp(V_{ij}^r)]$, k is 1 when the organic milk is in the choice set and k is 0 when the organic milk is not in the choice set.

The change in expected consumer welfare for household i is obtained by substituting equation (14) into equation (9):

(15) $$\Delta E(CS_i) = E\widetilde{(CS_i^1)} - E\widetilde{(CS_i^0)}$$

The sum of changes in expected consumer surplus and the distributions of individual welfare changes are presented in the next section.

V. Results

The econometric approach outlined above is applied to the A.C. Nielsen Homescan data to estimate the probabilistic demand equations at the disaggregate level of industry. A variety of starting values are attempted in estimation and the model converged to the same values in each attempt.

Table II-4 presents the parameter estimates for equation (10) and (11). The random coefficient γ_i is assumed to follow a lognormal distribution in which the log of γ_i is normally distributed. I parameterize the lognormal distribution in terms of the underlying normal. In other words, I estimate parameters m and s which are the mean and variance of the log of the coefficient. Then the mean and variance of γ_i are derived from the estimates of m and s. The median is exp(m), the mean is exp(m+s/2), and the variance is exp(sm+2)[exp(s)-1]. The point estimates of m and s, which are -0.67 and 0.0016 respectively, imply that the coefficient γ_i has the mean, median and variance of 0.51, 0.51, and 0.009 respectively as shown in Table4. In other words, the average of marginal utility of income in this sample is 0.51 and its standard deviation is 0.095.

The interaction terms of product and demographic characteristics have the expected signs. Households with higher income or/and higher education value organic milk more than households with lower income or/and lower education do. However, the results indicate that households with older heads do not value the organic characteristic as much as the ones with younger heads. The parameter estimates of product characteristics should be interpreted with the associated interaction terms. For example, a consumer who has almost zero values for both education and income will dislike organic milk. In reality, however, there is no household who has zero values for both of the characteristic variables. Consumers with average demographic characteristics like organic milk when the other factors are constant. The overall impact of organic factors on utility is calculated using the mean and median values of demographic characteristics given in Table3 and it is found that consumers on average prefer organic milk to conventional milk. The overall impact of fat content also can be interpreted in the same manner. Households with average demographic characteristics prefer lower fat milk to higher fat milk.

Elasticities for each consumer are computed following the equation (6) and (7). Table II-5 presents the median of own and cross price elasticities of the consumers in the sample. Own price elasticities are ranged from -2.6 to -1.4, which are reasonable compared to the estimates in other studies in milk demand. For example, Dhar and Foltz (2005) find own price elasticities between -4.4 and -1.04, and Alviola (2010) finds between -2.0 and -0.87.

Cross price elasticities are all positive as expected. In the discrete choice model, cross price elasticities are positive as long as the parameter estimates of price is negative because all the variables in cross price elasticities are in a form of exponential function, thus the parameter estimates of price solely determine the sign of cross price elasticities. Therefore, organic milk and conventional milk are always substitutes to each other in this study unlike the findings from the aggregate demand in the previous chapter. This can be a very restrictive property in some applications, but it is intuitively sound in this application because one type of milk is usually thought to be a substitute for other types of milk product at the UPC level rather than to be a complement. Of course different milk products can be complements for some households, but this model rules out those cases. Although this study cannot test whether two products are complements, cross price elasticities provide implications on the strength of substitution patterns. For example, the conventional milk is more substitutable for organic milk than what organic milk is substitutable for conventional milk. In addition, consumers tend to switch to the same package size milk products when there is an increase in the price of one good. Unlike the previous chapter, fat content and the labels of products do not determine substitution patterns in this model. Although some of the cross price elasticities in Table II-5 look the same for the same sized products, it is hard to say that the model presents IIA property because they differ in higher decimal points (6^{th} decimal point) and the ratio of the largest elasticity to the smallest one is between 3 and 5.

Following Wold and Jureen (1953), group elasticities are also computed by taking weighted average where the weights are the market shares of each item in the group. The group cross-price elasticities shown in Table II-6 also indicate the substitutability among the same size products. This result is consistent with the findings in the other studies in the demand for soft drinks at the UPC level. Although there is no previous study in milk demand at the UPC level, some studies in soft drinks, such as Guadagni and Little (1983) and Dube (2005), show that households tend to switch among products of the same package size.

The variety effects (VE) are computed by subtracting the counterfactual indirect utility in which consumers do not have organic option from the actual indirect utility. Indirect utility is transformed into dollar terms by dividing by the marginal utility of income estimated from random coefficient logit. The estimated total amount that consumers are willing to pay for the organic option is $4595.4 in this sample. This is equivalent to 4% of the total milk expenditure in the sample. Demographic distributions of welfare effects are shown in Table II-7 ~ Table II-12. Each table presents the distribution of average variety effects of demographic groups. This information would be very useful in the sense that it provides insight into the characteristics that differentiate the potential organic household from the potential conventional household.

Household income and education of the head of the household seem to be associated with the valuation of organic milk. The results indicate that the households with higher income value the organic milk more than the households with lower income do in general. The results also indicate that the households headed by someone with higher education appreciate the organic milk more than the ones with lower education. This could be because income and education are correlated, and higher education probably enhances the understanding of organic process of dairy produce and its impact on environment. Or this might be because the marginal utility of income is larger for low income households than for higher income households and the welfares in dollar term are smaller for lower income households since the welfare numbers are the utility divided by marginal utility of income.

The age of head in a household also seems to be a factor that distinguishes the consumer who values organic milk. Table II-7 shows that households with an older head appreciate organic option less than the ones with younger heads. The results imply that households with a head between 25 and 29 years old benefit the most from organic milk. Households headed by someone between 30 and 34 years old are ranked next. This can be explained by the fact that younger people have a tendency to accept new products more easily than older people. However, households with a head younger than 25 years old do not value organic milk as much as the others. This might be because consumers in this category do not earn income as much as older ones who are more experienced.

The presence of child does not have the expected effect. According to the results, consumers without a child benefit more from organic milk than ones with children although it is expected that young mothers tend to want organic milk for their children. However, among the households with children, welfare is greater as the age of child is smaller.

Although it is impossible to compare directly with other studies because there are no welfare studies on organic milk at the household level, the welfare distributions in this study are similar to the distributions of demand for organic milk at the household level. For example, according to Dimitri and Venezia (2007) households with higher education and income are more likely to purchase organic milk. Alviola and Capps (2010) also find that income and education play an important role in organic milk purchase while the presence of children does not affect the organic purchases.

Although the distributions of welfare effects present similar implications as the parameter estimates, it should be noted that each demographic variable in the distribution cannot be interpreted as a ceteris paribus factor that determines the amount of welfare effects of each individual while the demographic variable in utility function is a factor that determines the utility holding other variables constant. In other words, each distribution is estimated without controlling other demographic characteristics. Thus, the distribution depends on the set of demographic characteristics for each individual.

VI. Conclusions

The objective of this study is to investigate individual households' welfare improvement from organic milk introduction. Willingness to pay studies with individual household level data can yield more information than studies with aggregate level data because one can estimate the distributions of welfare effects according to consumers' demographic characteristics.

First, the demands for milk products are estimated for each individual household by adopting discrete choice approach. In order to take both observed and unobserved heterogeneous preferences, random coefficient logit model is specified for each household's probability to choose an alternative. Parametric distributions for the random coefficients are estimated. The results indicate that consumers with higher income and education are more likely to purchase organic product, but less likely to buy higher fat milk. It is also found that the households with elder heads are more likely to prefer higher fat milk and conventional milk. Cross price elasticities show that conventional milk is more substitutable to organic milk than organic milk is substitutable for conventional milk. Cross price elasticities also indicate the substitutability among the same package size products. Secondly, variety effects are computed for each individual, and are approximately 4% of total milk expenditure in the sample. Finally, the distributions of welfare effects are estimated. Although the implications are not exactly the same, the distributions of welfare effects yield similar implications as the parameter estimates.

The mixed logit model employed for this study is well known for its competence in modeling individual economic behavior. The model has the advantage that it requires substantially fewer parameters to be estimated than a typical flexible functional form such as Almost Ideal Demand System requires. Thus, the number of alternatives that a system of demand equations can accommodate in the choice set is not limited in this model, and qualitative variables such as demographic characteristics can also be included in the model as many as desired. Secondly, the number of zero observations, which a researcher frequently encounters when s/he estimates demand equations with disaggregate level data, is relatively small while a lot of zero purchases occur in the estimation of flexible demand functions because the functions are generally in the form of share equations. Modeling the zero purchasing behavior can be computationally cumbersome because it requires the integrals of multivariate density function. In addition, the model satisfies the restrictions of consumer demand theory, does not hold IIA properties, and is flexible enough to approximate any RUM consistent choice probabilities. Although the model yields more flexible cross price elasticities than the standard logit model, however, it still imposes certain degree of restrictions on the substitution patterns compared with the conventional flexible demand functions. In addition, this study assumes that consumers choose only one alternative on each shopping trip for computational simplicity as mentioned above. However, this assumption can be very restrictive in the applications of highly storable goods market such as wine and soft drinks, and the computational difficulties one will face when s/he models multiple choices can be a limitation of this model. Finally, the linear dependence of systematic utility on economic variables makes this model quite restrictive.

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Table II- 1 List of Products in the Choice Set

Item	Market Share	Brand	Organic	Size	Fat
1	4.2	Private Label	0	1	2
2	4.0	Composite Product of Organic	1	2	2
3	3.3	Private Label	0	1	0
4	2.8	Private Label	0	1	3
5	2.8	Private Label	0	1	0
6	2.8	Private Label	0	1	2
7	2.4	Private Label	0	2	2
8	2.2	Private Label	0	2	2
9	2.3	Private Label	0	1	0
10	2.0	Private Label	0	2	3
11	2.0	Private Label	0	1	2
12	2.0	Private Label	0	1	2
13	1.8	Private Label	0	1	1
14	1.8	Private Label	0	1	3
15	1.7	Private Label	0	1	2
16	1.7	PET	0	1	3
17	1.8	Private Label	0	1	0
18	2.4	Country Fresh	0	1	0
19	1.6	Private Label	0	2	0
20	2.1	Country Fresh	0	1	2
21	1.6	Private Label	0	1	1

Table II- 2 Continued

22	1.5	Private Label	0	1	0
23	1.4	Private Label	0	1	1
24	1.2	Private Label	0	1	3
25	1.1	Private Label	0	2	1
26	1.1	Private Label	0	2	0
27	1.1	PET	0	1	2
28	1.0	Private Label	0	2	2
29	0.9	Private Label	0	2	0
30	0.9	Private Label	0	2	3
31	0.9	Private Label	0	1	2
32	0.9	Private Label	0	2	2
33	1.0	Private Label	0	1	3
34	1.3	Private Label	0	1	3
35	0.9	Private Label	0	2	1
36	0.9	Private Label	0	1	3
37	1.0	Private Label	0	1	1
38	0.9	Private Label	0	1	1
39	1.0	Private Label	0	1	0
40	0.7	Private Label	0	2	3
41	31.2	Outside Goods	0	1.5	1.6

All of organic milk products are included in item2. Size1=Gallon, Size2=Half Gallon. Fat 0=Fat Free, 1=1% Low Fat, 2= 2% Reduced Fat, 3=Whole Milk, 2.3=Soy Milk
values for item 41(outside goods) are mean values

Table II- 3 Market Shares by Size and Fat of Products

		Market Share
Size	Gallon	49.0
	Half Gallon	19.8
	Outside	31.2
Fat	Fat Free	18.7
	Low Fat	8.6
	Reduced Fat	23.2
	Whole Milk	18.2
	Outside	31.2

Table II- 4 Descriptive Statistics for Observed Household Attributes

	Mean	Standard Deviation	Min	Max	Median
Income	10.7	0.6	8.5	11.5	10.8
Education	4.1	1.1	1.0	6.0	4.0
Age of Head	5.0	0.9	2.5	6.0	5.2
Household Size	2.6	1.3	1.0	9.0	2.0

note: The values for income are the log of income
Education 1= Grade School, 2=Some High School, 3= Graduate High School,
4= Some College, 5= Graduated College, 6= Post College Grad
Age of Head is divided by 10

Table II- 5 Parameter Estimates from the Mixed Logit Model

Variable	Parameter	Value	Standard Error
Income-Price	Mean of ln(coefficient)	-0.67***	0.08
	Std Dev of ln(coefficient)	0.04***	0.05
	Mean of Coefficient	0.51	
	Median of Coefficient	0.51	
	Std Dev of Coefficient	0.095	
Fat	Mean	1.08***	0.3
	Std. Dev.	-0.02	0.04
Fat*Age	Coefficient	-0.04***	0.01
Fat*Edu	Coefficient	-0.13***	0.01
Fat*Income	Coefficient	-0.11***	0.01
Organic	Mean	-4.09*	2.48
	Std. Dev.	2.60	0.25
Organic*Age	Coefficient	-0.16**	0.05
Organic*Edu	Coefficient	1.06***	0.06
Organic*Income	Coefficient	0.63***	0.08
Size	Mean	-2.49***	0.42
	Std. Dev.	2.27	0.18
Size*Family Size	Coefficient	-0.52***	0.03
	SLL at Convergence	115959.09	

Note: values for price related parameters are estimated in the form of ln(coefficient).
The estimates for size variables should be interpreted as an opposite direction since the values of size are assigned in opposite way, i.e. gallon=1 and half gallon=2.

Table II- 6 Elasticity Estimates from the Mixed Logit Model

Item				2	3	5	9	17	22	39
	Brand			Organic	CTL	CTL	CTL	CTL	CTL	CTL
		Fat			FF	FF	FF	FF	FF	FF
			size	2	1	1	1	1	1	1
2	Organic		2	-2.029	0.027	0.022	0.014	0.011	0.011	0.008
3	CTL	FF	1	0.042	-1.900	0.066	0.043	0.033	0.031	0.023
5	CTL	FF	1	0.042	0.081	-1.798	0.043	0.033	0.031	0.023
9	CTL	FF	1	0.042	0.081	0.066	-1.477	0.033	0.031	0.023
17	CTL	FF	1	0.042	0.081	0.066	0.043	-1.424	0.031	0.023
22	CTL	FF	1	0.042	0.081	0.066	0.043	0.033	-1.604	0.023
39	CTL	FF	1	0.042	0.081	0.066	0.043	0.033	0.031	-1.859
19	CTL	FF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
26	CTL	FF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
29	CTL	FF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
13	CTL	LF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
21	CTL	LF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
23	CTL	LF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
37	CTL	LF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
38	CTL	LF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
25	CTL	LF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
35	CTL	LF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
1	CTL	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
6	CTL	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
11	CTL	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
12	CTL	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
15	CTL	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
31	CTL	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
7	CTL	RF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
8	CTL	RF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
28	CTL	RF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
32	CTL	RF	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
4	CTL	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
14	CTL	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
24	CTL	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
33	CTL	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
36	CTL	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
10	CTL	WH	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
30	CTL	WH	2	0.119	0.031	0.025	0.016	0.013	0.012	0.009
40	CTL	WH	2	0.119	0.031	0.025	0.017	0.013	0.012	0.009
18	CNTY	FF	1	0.042	0.081	0.066	0.043	0.034	0.031	0.023
20	CNTY	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
27	PET	RF	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
16	PET	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
34	CNTY	WH	1	0.042	0.081	0.066	0.043	0.033	0.031	0.023
41	Outside			0.079	0.055	0.045	0.029	0.023	0.021	0.016

Table II- 7 Continued

Item				19	26	29	13	21	23	37	38
	Brand			CTL	CTL	CTL	CTL	CTL	CTL	CTL	CTL
		Fat		FF	FF	FF	LF	LF	LF	LF	LF
			Size	2	2	2	1	1	1	1	1
2	Organic		1	0.044	0.030	0.019	0.015	0.013	0.009	0.007	0.007
3	CTL	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
5	CTL	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
9	CTL	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
17	CTL	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
22	CTL	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
39	CTL	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
19	CTL	FF	2	-2.570	0.056	0.035	0.017	0.015	0.011	0.009	0.009
26	CTL	FF	2	0.082	-2.496	0.035	0.017	0.015	0.011	0.009	0.009
29	CTL	FF	2	0.082	0.056	-1.763	0.017	0.015	0.011	0.009	0.009
13	CTL	LF	1	0.018	0.012	0.008	-1.832	0.040	0.028	0.023	0.023
21	CTL	LF	1	0.018	0.012	0.008	0.044	-1.954	0.028	0.023	0.023
23	CTL	LF	1	0.018	0.012	0.008	0.044	0.040	-1.505	0.023	0.023
37	CTL	LF	1	0.018	0.012	0.008	0.044	0.040	0.028	-1.801	0.023
38	CTL	LF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	-1.983
25	CTL	LF	2	0.082	0.056	0.035	0.017	0.015	0.011	0.009	0.009
35	CTL	LF	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
1	CTL	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
6	CTL	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
11	CTL	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
12	CTL	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
15	CTL	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
31	CTL	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
7	CTL	RF	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
8	CTL	RF	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
28	CTL	RF	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
32	CTL	RF	2	0.082	0.056	0.035	0.017	0.015	0.011	0.009	0.009
4	CTL	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
14	CTL	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
24	CTL	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
33	CTL	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
36	CTL	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
10	CTL	WH	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
30	CTL	WH	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
40	CTL	WH	2	0.082	0.056	0.034	0.017	0.015	0.011	0.009	0.009
18	CNTY	FF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
20	CNTY	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
27	PET	RF	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
16	PET	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
34	CNTY	WH	1	0.018	0.012	0.008	0.044	0.040	0.028	0.023	0.023
41	Outside			0.044	0.030	0.018	0.030	0.027	0.019	0.015	0.015

Table II- 8 Continued

Item				25	35	1	6	11	12	15	31
	Brand			CTL	CTL	CTL	CTL	CTL	CTL	CTL	CTL
		Fat		LF	LF	RF	RF	RF	RF	RF	RF
			Size	2	2	1	1	1	1	1	1
2	Organic		1	0.031	0.025	0.033	0.019	0.012	0.014	0.014	0.007
3	CTL	FF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
5	CTL	FF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
9	CTL	FF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
17	CTL	FF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
22	CTL	FF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
39	CTL	FF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
19	CTL	FF	2	0.059	0.047	0.038	0.023	0.015	0.016	0.016	0.008
26	CTL	FF	2	0.059	0.047	0.038	0.023	0.015	0.016	0.016	0.008
29	CTL	FF	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
13	CTL	LF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
21	CTL	LF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
23	CTL	LF	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
37	CTL	LF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
38	CTL	LF	1	0.013	0.011	0.101	0.059	0.038	0.042	0.042	0.021
25	CTL	LF	2	-2.517	0.047	0.039	0.023	0.015	0.016	0.016	0.008
35	CTL	LF	2	0.059	-2.627	0.039	0.023	0.015	0.016	0.016	0.008
1	CTL	RF	1	0.013	0.011	-1.776	0.059	0.038	0.043	0.042	0.021
6	CTL	RF	1	0.013	0.011	0.101	-1.592	0.038	0.043	0.042	0.021
11	CTL	RF	1	0.013	0.011	0.101	0.059	-1.464	0.043	0.042	0.021
12	CTL	RF	1	0.013	0.011	0.101	0.059	0.038	-1.646	0.042	0.021
15	CTL	RF	1	0.013	0.011	0.101	0.059	0.038	0.043	-1.955	0.021
31	CTL	RF	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	-1.875
7	CTL	RF	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
8	CTL	RF	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
28	CTL	RF	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
32	CTL	RF	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
4	CTL	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
14	CTL	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
24	CTL	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
33	CTL	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
36	CTL	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
10	CTL	WH	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
30	CTL	WH	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
40	CTL	WH	2	0.059	0.047	0.039	0.023	0.015	0.016	0.016	0.008
18	CNTY	FF	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
20	CNTY	RF	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
27	PET	RF	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
16	PET	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
34	CNTY	WH	1	0.013	0.011	0.101	0.059	0.038	0.043	0.042	0.021
41	Outside			0.031	0.025	0.068	0.040	0.026	0.029	0.029	0.014

Table II- 9 Contined

Item				7	8	28	32	4	14	24	33	36
	Brand			CTL	CTL	CTL	CTL	CTL	CTL	CTL	CTL	CTL
		Fat		RF	RF	RF	RF	WH	WH	WH	WH	WH
			Size	2	2	2	2	1	1	1	1	1
2	Organic	.	1	0.067	0.057	0.024	0.019	0.021	0.012	0.008	0.006	0.006
3	CTL	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
5	CTL	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
9	CTL	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
17	CTL	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
22	CTL	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
39	CTL	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
19	CTL	FF	2	0.130	0.109	0.045	0.036	0.025	0.014	0.009	0.007	0.008
26	CTL	FF	2	0.130	0.109	0.045	0.036	0.025	0.014	0.009	0.007	0.008
29	CTL	FF	2	0.130	0.109	0.046	0.036	0.025	0.014	0.009	0.007	0.008
13	CTL	LF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
21	CTL	LF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
23	CTL	LF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
37	CTL	LF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
38	CTL	LF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
25	CTL	LF	2	0.130	0.109	0.045	0.036	0.025	0.014	0.009	0.007	0.008
35	CTL	LF	2	0.130	0.109	0.045	0.036	0.025	0.014	0.009	0.007	0.008
1	CTL	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
6	CTL	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
11	CTL	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
12	CTL	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
15	CTL	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
31	CTL	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
7	CTL	RF	2	-2.443	0.109	0.046	0.036	0.025	0.014	0.009	0.007	0.008
8	CTL	RF	2	0.130	-2.525	0.046	0.036	0.025	0.014	0.009	0.007	0.008
28	CTL	RF	2	0.130	0.109	-2.193	0.036	0.025	0.014	0.009	0.007	0.008
32	CTL	RF	2	0.130	0.109	0.046	-1.975	0.025	0.014	0.009	0.007	0.008
4	CTL	WH	1	0.029	0.024	0.010	0.008	-1.820	0.037	0.025	0.018	0.020
14	CTL	WH	1	0.029	0.024	0.010	0.008	0.065	-1.658	0.025	0.018	0.020
24	CTL	WH	1	0.029	0.024	0.010	0.008	0.065	0.037	-1.740	0.018	0.020
33	CTL	WH	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	-1.528	0.020
36	CTL	WH	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	-1.900
10	CTL	WH	2	0.130	0.109	0.046	0.036	0.025	0.014	0.009	0.007	0.008
30	CTL	WH	2	0.130	0.109	0.046	0.036	0.025	0.014	0.009	0.007	0.008
40	CTL	WH	2	0.130	0.109	0.046	0.036	0.025	0.014	0.009	0.007	0.008
18	CNTY	FF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
20	CNTY	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
27	PET	RF	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
16	PET	WH	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.018	0.020
34	CNTY	WH	1	0.029	0.024	0.010	0.008	0.065	0.037	0.025	0.019	0.020
41	Outside			0.069	0.058	0.024	0.019	0.044	0.025	0.017	0.012	0.013

Table II- 10 Continued

Item				10	30	40	18	20	27	16	34
	Brand			CTL	CTL	CTL	CNTY	CNTY	PET	PET	CNTY
		Fat		WH	WH	WH	FF	RF	RF	WH	WH
			Size	2	2	2	1	1	1	1	1
2	Organic		1	0.052	0.025	0.016	0.013	0.012	0.007	0.011	0.007
3	CTL	FF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
5	CTL	FF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
9	CTL	FF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
17	CTL	FF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
22	CTL	FF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
39	CTL	FF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
19	CTL	FF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
26	CTL	FF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
29	CTL	FF	2	0.099	0.048	0.031	0.015	0.014	0.008	0.014	0.009
13	CTL	LF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
21	CTL	LF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
23	CTL	LF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
37	CTL	LF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
38	CTL	LF	1	0.022	0.010	0.007	0.038	0.037	0.022	0.036	0.023
25	CTL	LF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
35	CTL	LF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
1	CTL	RF	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
6	CTL	RF	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
11	CTL	RF	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
12	CTL	RF	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
15	CTL	RF	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
31	CTL	RF	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
7	CTL	RF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
8	CTL	RF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
28	CTL	RF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
32	CTL	RF	2	0.099	0.048	0.031	0.014	0.014	0.008	0.014	0.009
4	CTL	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
14	CTL	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
24	CTL	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
33	CTL	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
36	CTL	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	0.023
10	CTL	WH	2	-2.446	0.048	0.031	0.014	0.014	0.008	0.014	0.009
30	CTL	WH	2	0.099	-2.542	0.031	0.014	0.014	0.008	0.014	0.009
40	CTL	WH	2	0.100	0.048	-2.127	0.014	0.014	0.008	0.014	0.009
18	CNTY	FF	1	0.022	0.010	0.007	-1.208	0.037	0.022	0.036	0.023
20	CNTY	RF	1	0.022	0.011	0.007	0.038	-1.359	0.022	0.036	0.023
27	PET	RF	1	0.022	0.011	0.007	0.038	0.037	-1.655	0.036	0.023
16	PET	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	-1.629	0.023
34	CNTY	WH	1	0.022	0.011	0.007	0.038	0.037	0.022	0.036	-1.502
41	Outside			0.053	0.025	0.016	0.026	0.025	0.015	0.024	0.016

Table II- 11 Elasticities at the Group Level

				1	1	1	1	2	2	2	2	1	1	1
				CTL	CTL	CTL	CTL	CTL	CTL	CTL	CTL	CNTY	PET	CNTY
				FF	LF	RF	WH	FF	LF	RF	WH	FF	RF	WH
			-2.03	0.09	0.05	0.10	0.05	0.09	0.06	0.17	0.09	0.01	0.02	0.02
1	CTL	FF	0.04	-1.47	0.16	0.30	0.16	0.04	0.02	0.07	0.04	0.04	0.06	0.06
1	CTL	LF	0.04	0.28	-1.68	0.30	0.16	0.04	0.02	0.07	0.04	0.04	0.06	0.06
1	CTL	RF	0.04	0.28	0.16	-1.46	0.16	0.04	0.02	0.07	0.04	0.04	0.06	0.06
1	CTL	WH	0.04	0.28	0.16	0.30	-1.62	0.04	0.02	0.07	0.04	0.04	0.06	0.06
2	CTL	FF	0.12	0.11	0.06	0.12	0.06	-2.23	0.11	0.32	0.18	0.01	0.02	0.02
2	CTL	LF	0.12	0.11	0.06	0.12	0.06	0.17	-2.51	0.32	0.18	0.01	0.02	0.02
2	CTL	RF	0.12	0.11	0.06	0.12	0.06	0.17	0.11	-2.15	0.18	0.01	0.02	0.02
2	CTL	WH	0.12	0.11	0.06	0.12	0.06	0.17	0.11	0.32	-2.30	0.01	0.02	0.02
1	CNTY	FF	0.04	0.28	0.16	0.30	0.16	0.04	0.02	0.07	0.04	-1.21	0.06	0.06
1	PET	RF	0.04	0.28	0.16	0.30	0.16	0.04	0.02	0.07	0.04	0.04	-1.43	0.06
1	CNTY	WH	0.04	0.28	0.16	0.30	0.16	0.04	0.02	0.07	0.04	0.04	0.06	-1.55

Table II- 12 Distribution of Variety Effect by Age

Age of Head	Number of Households	Total Variety Effect in Dollars	Average VE per Household
~25	40	5.2	0.129
25~29	558	113.4	0.203
30~34	2286	384.9	0.168
35~39	3250	453.6	0.140
40~44	4372	543.8	0.124
45~49	5420	665.8	0.123
50~54	5242	647.1	0.123
55~59	8709	886.0	0.102
60~	8812	891.7	0.101

Table II- 13 Distribution of Variety Effect by Education

Education	Number of Households	Total Variety Effect in Dollars	Average VE per Household
Grade school	450	4.2	0.009
Some high school	1608	28.1	0.017
Graduate high school	10621	457.4	0.043
Some college	10906	980.1	0.090
Graduate college	10860	1852.7	0.171
Post college graduate	4244	1268.9	0.299

Table II- 14 Distribution of Variety Effect by Income

Income	Number of Households	Total Variety Effect in Dollars	Average VE per Household
Under $5000	295	15.1	0.051
5000-7999	373	12.2	0.033
8000-9999	211	7.4	0.035
10,000-11,999	417	24.3	0.058
12,000-14,999	1184	65.3	0.055
15,000-19,999	2391	126.6	0.053
20,000-24,999	2545	218.7	0.086
25,000-29,999	2683	217.6	0.081
30,000-34,999	3504	329.7	0.094
35,000-39,999	2655	275.3	0.104
40,000-44,999	2264	243.4	0.108
45,000-49,999	2383	230.9	0.097
50,000-59,999	5000	629.2	0.126
60,000-69,999	3392	483.4	0.143
70,000-99,999	6261	1125.2	0.180
100,000 & Over	3131	587.0	0.187

Table II- 15 Distribution of Variety Effect by Household Size

Number of Members in the Household	Number of Households	Total Variety Effect in Dollars	Average VE per Household
1	6491	1028.6	0.158
2	16157	1922.3	0.119
3	6870	808.5	0.118
4	5692	656.7	0.115
5	2379	149.8	0.063
6	980	21.5	0.022
7	96	3.3	0.034
9	24	0.7	0.028

Table II- 16 Distribution of Variety Effect between Households with and without Children

Presence of Children	Number of Households	Total Variety Effect in Dollars	Average VE per Household
No Child	27298	3347.1	0.123
At Least One Child	11391	1244.3	0.109

Table II- 17 Distribution of Variety Effect by the Average Age of Children

Average Age of Children	Number of Households	Total Variety Effect in Dollars	Average VE per Household
3	3349	451.7	0.135
9	2327	285.7	0.123
12	2216	158.4	0.071
15	3499	348.5	0.100

CHAPTER 3

The Competitive Effects of Organic Milk Introduction

I. Introduction

The purpose of this chapter is to provide a complete welfare analysis by extending the previous two essays with the supply side. As mentioned in the previous chapters, consumer's welfare change from new product introduction can be decomposed into two effects, variety effect (VE) and competitive/price effect (PE). The variety effect measures consumer's willingness-to-pay for the utility increase from the additional products holding the existing product prices constant at the post-introduction level. The price effect measures the welfare change from the existing products' price changes that are due to enhanced competition among suppliers after the introduction of new goods. Compensating variation can be obtained in a general equilibrium framework combining the two effects. The previous two essays focus on the demand analysis and the variety effects. This chapter refines the welfare analysis by accounting for the price competition on the supply side of the market.

Hausman and Leonard (2002) provide both "direct" and "indirect" estimates of price effects when they analyze consumer benefits from a new brand introduction in the U.S. bath tissue market. Direct price effects estimate price changes for existing products using both pre- and post-introduction data without putting any competitive structure on the model. Indirect price effects only use post-introduction data utilizing profit maximizing behavior of firms to simulate counterfactual prices at which consumers would have to pay for the existing products if the new products were not introduced. By assuming specific types of competition of the market, indirect price effects rely on the model assumptions while direct price effects purely rely on the data. In many welfare studies, indirect estimation is frequently used to predict price effects due to the difficulties that may occur in some applications of direct estimation. First, it is hard to clearly distinguish pre- and post-introduction data when the exact time of introduction is not known or the product is gradually introduced over time and region. Second, it is difficult to control other variables that affect the prices if the emergence of other factors coincides with the introduction of the new product. Finally, welfare estimates differ according to the length of time period included in the computation as shown in the first essay and in Ferrier and Zhen (2010). Since the time of organic milk introduction cannot be represented as a single point, although the data for organic purchases in this region are recorded from 2004, this chapter employs indirect estimation of price effects utilizing the results from both the discrete choice and multistage demand analyses.

Petrin (2002) uses the indirect method to measure the benefits of minivan introduction assuming Bertrand-Nash competition. Nevo (2001) examines market power in the ready-to-eat cereal industry by comparing price-cost margins that are computed with the indirect method under various assumptions of competition. The weakness of the indirect approach is that it is hard to test if the assumed model fits the industry unless one can observe the actual price-cost margins prior to introduction of new products. In some cases, however, estimated marginal costs under different competition models can give information about the market structure. For example, in this study marginal costs estimated with the collusion model showed negative marginal costs. Therefore, Bertrand Nash oligopoly is naturally assumed for the rest of the analysis[17].

In this paper, I follow Nevo (2003) to indirectly compute the consumer benefits from enhanced competition due to the organic milk introduction adopting the Bertrand Nash competition model. The same datasets are used as in the previous essays. Since marginal cost data are not available at the firm level, marginal costs are inferred using the markup equations and elasticity estimates from the demand analyses. Marginal costs are estimated for both multistage demand system and discrete choice demand approaches, but the price effect is not estimated in the multistage demand approach since the realized estimates are not reasonable under the Bertrand assumption. A brief discussion on the structure of the U.S.

[17] Among other oligopoly models, such as Stackelberg and Cournot, only the Bertrand Nash and collusion models are tried.

dairy industry is provided in section II and the empirical model is outlined in Section III. Section IV presents results and Section V concludes and briefly compares two approaches.

II. Fluid Milk Industry[18]

A brief discussion on milk handling from dairy farms to consumers and the structure of the industry is provided in this section. There are four major players in the dairy market: dairy farmers, processors, cooperatives and retailers. Raw milk produced by dairy farmers is purchased by processors (or handlers). The dairy processing industry comprises both processing milk for fluid consumption and manufacturing dairy products such as butter and cheese. Fluid milk processing includes standardization, pasteurization, homogenization and vitamin fortification.[19] A cooperative is an enterprise owned by and operated for the benefits of those who use the services. There are two basic types of dairy cooperatives: bargaining-only and manufacturing/processing. The bargaining-only cooperatives negotiate prices and terms of trade for members' milk with processors. Many manufacturing/processing cooperatives bargain for price and market their members' milk through their own processing facilities. Manufacturing cooperatives play major roles in the hard manufactured product markets, such as cheese and butter. Processed milk products are distributed to consumers through retailers, which include traditional supermarkets, mass-discount stores, gourmet food stores and convenient stores, or distributed directly from processors to commercial customers, such as military, schools and restaurants.

The U.S. dairy industry has experienced consolidation and concentration over time in all segments discussed above. Increased dairy cow output and advances in dairy farm

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[18] This section is heavily drawn from "Consolidation and Concentration in the U.S. Dairy Industry," Dennis A. Shields and "Milk Processing page of Cornell University" at http://www.milkfacts.info/Milk%20Processing/Milk%20Processing%20Page.htm.

[19] To achieve standardization, raw milk is separated into a cream portion and a skim portion. The cream portion is then added back to the skim portion to produce the desired fat content milk. Common products are whole milk (3.25% fat), 2% and 1% fat milk and skim milk (less than 0.1% fat). The majority of U.S. fluid milk is pasteurized using high temperature short time process to meet the requirements for consumer safety. The purpose of homogenization is to reduce the milk fat globules size so that they can stay evenly distributed in milk. Fluid milk is often fortified with vitamin A and vitamin D.

technology led to a sharp reduction in the number of dairy farms. The number of dairy farm operations has decreased to 65,000 as of December 31, 2009 from more than a million in 1960s while the productivity (milk per cow) have more than offset declines in the number of dairy farms and cows. The number of dairy cooperatives has been declining since the 1940s as cooperatives merged to take advantage of economic gains from more centralized management. As a result, 79% of milk produced in the U.S. was marketed by the 50 largest dairy cooperatives and top four cooperatives take 40% of market share in 2008. The number of dairy processing plants and manufacturing companies also declined over the years and the level of concentration has recently increased following mergers such as the case between Suiza, Inc. and Dean Foods. Consequently, the four largest firms accounted for 43% of processed fluid milk market in 2002. While the level of national concentration is not unusually high compared to some other industries such as meatpacking (59%) and soybean processing (80%), farmers and policymakers are concerned that local or regional market are more concentrated. The four-firm concentration ratio in the retail sector also increased to 36% in 2005 from about 17% in the 1990s following acquisitions and mergers by large grocery stores, such as Kroger Co., Albertson's, Ahold USA and Safeway.

The changing structure of the U.S. dairy industry has generated concerns about competition in the market. Although consolidations and concentration might result in an efficiency gain where large quantities of products can be produced at lower costs and provided to consumers at lower prices, there are more concerns about market power and antitrust violations. These concerns are reflected on the current lawsuits filed against Dean Foods, the largest fluid milk processor in the U.S., and other milk processors and cooperatives for their collusive activities that have resulted in lowering the prices received by farmers.

III. Model

In this paper, I present the supply side study to evaluate the price effects of organic milk introduction. By adding this part to the previous two essays, the dissertation as a whole is able to provide the welfare analyses in a partial equilibrium framework incorporating structural models of demand and supply. The marginal cost of each product is assumed to be constant before and after introduction of organic milk. The milk processing industry is assumed to exhibit constant returns to scale and its marginal cost is assumed to be constant. Finally, supermarkets set retail prices as a fixed markup over the wholesale prices of the corresponding products.

1) Supply and Equilibrium

Suppose there are F multiproduct firms competing in the market and each of them produces J_f items where $J_f \in J$ is a subset of j=1,2,…, J products. Then the profit that an individual firm f expects from producing J_f products can be presented as follows:

$$\Pi_f = M \sum_{j \in J_f} \left(p_j - mc_j\right) s_j(p, X; \theta) + C_f$$

where M is the market size, mc_j is the constant marginal cost of product j, C_f is the fixed cost, p_j is the price of product j, $s_j(p, X; \theta)$ is the market share of product j and $q_j(p, X; \theta) = M s_j(p, X; \theta)$. The first order conditions for static price competition are given by

$$(1) \qquad s_j(p, X; \theta) + \sum_{j \in J_f} (p_r - mc_r) \frac{\partial s_r(p, X; \theta)}{\partial p_j} = 0$$

This set of J equations implies that the price of single product is determined at the equilibrium where each multi-product firm maximizes its profits from all products produced within the firm. In vector notation, the equations above can be presented as follow.

$$(2) \qquad s(p) + \Omega(p - mc) = 0$$

where s(p), p and mc are Jx1 vectors of market shares, prices and marginal costs. Ω is a JxJ matrix with $\Omega_{jr} = \Omega^{*}_{jr} * S_{jr}$, $S_{rj} = \partial s_r / \partial p_j$, $j, r = 1, \ldots, J$ and Ω^{*}_{jr} is defined as

$$\Omega^{*}_{jr} = \begin{cases} 1, if\ \exists f: \{r, j\} \subset J_f \\ 0, otherwise \end{cases}$$

This matrix is called the ownership matrix which implies competition and ownership structure among the brands and firms. The definition given above implies that firms maximize their profits from all the brands they produce. If the firms separately maximize their profits from single brands no matter how many brands of milk each firm produces, the ownership matrix should be defined with an identity matrix. If the firms collude in price, all the elements of the matrix should be ones.

Equation (2) can be rewritten as below to infer the unknown marginal costs for each firm. Given the equilibrium prices and demand estimates, marginal costs can be obtained by solving equation (3) for marginal costs.

(3) $mc = p + \Omega^{-1} s(p)$

The new equilibrium prices when there is no organic milk in the market can be estimated by solving the set of markup equations in equation (2) using the marginal costs obtained in equation (3) and a new ownership matrix where organic milk is removed. The dimension of the new matrix is (J-1)x(J-1) in this application since the number of new product is one. The estimated new equilibrium prices represent the counterfactual prices at which the firms would set for the conventional milk if they compete without organic product in the market. The new equilibrium prices hold under the assumption that the marginal costs do not change before and after introduction of organic milk.

2) Consumer Welfare

The welfare effect is measured with compensating variation (CV). The compensating variation is defined as the additional minimum expenditure that consumers are willing to pay to maintain utility at the post introduction level if organic milk is removed from the market. CV can be analytically derived from ordinary (uncompensated) demand function through duality theory although the exact formulas are different depending on the particular specifications of the demand equations. As argued in Hausman and Leonard (2001), CV can be decomposed into the variety effect and the price effect according to the sources of welfare changes as shown below:

(4) $CV = e(p_1, p_N, u_1) - e(p_0, p_N^*(p_0), u_1)$

$$= [e(p_1, p_N, u_1) - e(p_1, p_N^*(p_1), u_1)] + [e(p_1, p_N^*(p_1), u_1) - e(p_0, p_N^*(p_0), u_1)]$$

where p_1 is the vector of post-introduction prices of existing products, p_N is the post-introduction price of the new product, u_1 is the post-introduction utility level, and p_0 is the vector of pre-introduction prices of existing products. The function $p_N^*(p)$ defines the 'virtual' price for the new product, which is the reservation price where demand for the new product would be zero given the prices of other products. Terms in the first bracket denote the variety effect that is the additional expenditure when having additional milk choice in the choice set holding other prices constant at the original equilibrium. The second bracket is the price effect that is measured by the expenditure changes in the market without organic milk solely from the changes in conventional milk prices due to the new good holding other factors constant. The virtual prices in equation (4) do not need to be actually evaluated in the discrete choice model due to the way that the functional form of expenditure function is defined, while they need to be evaluated in the multi-stage demand system approach as described in the first essay.

Hausman (1981) derives straightforward expressions for the expenditure functions from uncompensated demand estimates in case of log linear demand equation. The exact formula can be presented as equations (17) and (19) in the first essay. Small and Rosen (1981) derive the expenditure function in a closed form equation and show the change in expenditures as below under the logit assumptions if the marginal utility of income for each household is approximately independent of the price and quality of the goods:

(5) $\Delta e = (\Delta E)/N = \frac{1}{\alpha_i}\left[\ln[\sum_{j=1}^{J} \exp(V_{ij})]\right]_{\mathrm{V}_\mathrm{i}^0}^{\mathrm{V}_\mathrm{i}^1}$

where α_i is the marginal utility of income, V_i^1 is the utility at the original equilibrium and V_i^0 is the utility at the counterfactual equilibrium. In this paper, the original equilibrium is when organic milk is introduced in the market. The counterfactual equilibrium is the market without organic milk.

The variety effects are estimated in the previous essays. In this chapter, the price effects are evaluated with the counterfactual prices indirectly estimated from the first order conditions of profit maximization as described above.

IV. Estimation

1) Discrete choice model

The dataset defined for the analysis in the second essay consists of retail sales information of selected metropolitan areas in North Carolina, which are Raleigh, Durham, Chapel-Hill and Charlotte. There exist seven major firms distributing 40 brands of milk products of which total market share take about 60% in this market. The rest of brands are assumed to be one brand, which is called outside good, and marketed by a hypothetical firm. Thus eight firms and 41 brands are subject to the analysis. The 40 brands include private labels that are processed by grocery chains. As assumed in the estimation of demand, various brands of organic milk are consolidated as one brand for simplicity[20] and it is assumed to be produced by Dean Food, the largest milk process company in the nation, because the company leads the organic milk market by taking more than 70 percent of market share among the organic milk brands.

Since the data for marginal costs, such as raw milk price paid to dairy farmers and bottling costs, are not available at the individual firm/processor level, marginal costs are inferred by solving Equation (3) using the ownership matrix with organic milk brand. The derivatives of shares with respect to prices are computed with the elasticity estimates from

[20] The market shares of individual organic milk brands are very small except for one brand, Horizon Organic that is produced by Dean Food.

the demand analysis. The median elasticities among the elasticity estimates of individual households are used while the prices and shares are the actual data. Collusion and Bertrand-Nash oligopoly ownership matrices are constructed, but the collusion model generated negative marginal cost estimates. Thus the rest of the analysis is conducted with the Bertrand model.

Counterfactual prices at which manufacturers would set for conventional milk brands when organic milk product is not introduced in the market are evaluated using the ownership matrix without organic milk. Equation (2) is solved for prices utilizing the estimated marginal costs under the assumption that marginal costs do not change over the time period prior to and when organic milk is introduced in the markets.

Note that the price data used here reflect retail prices while this paper analyzes manufacturers' behavior. As described in section II, raw milk is produced by dairy farmers and sold to processors usually through cooperatives as middle men. The milk products that consumers purchase are processed through pasteurization and homogenization, bottled and distributed by processors. There usually is another level of distribution between consumers and processors in the milk industry, which can be represented by retail stores, such as convenient stores, grocery stores and supermarkets[21]. Since the data observed are retail prices rather than wholesale prices that milk processors receive, and because this study excludes direct transactions between processors and commercial consumers, an additional assumption is necessary for the profit equations of manufacturers described in Equation (2) to hold. Following the convention in many of empirical Industrial Organization papers, I assume that retailers set price as a fixed markup or a constant margin over the corresponding wholesale price. Hausman and Leonard (2002) show that retail prices and retail demand elasticities can be used for the first order conditions of manufacturers under the assumption of constant

[21] Milk products can be distributed through both processors and retailers. Households purchase milk from retail stores, such as convenient store, supermarket, conventional grocery store and gourmet food store, but other types of commercial consumers, such as schools and restaurants, usually purchase directly from the manufacturers. The data obtained for this study reflect the prices at retail outlets.

margin or markup. Suppose that w is the wholesale price that processors receive and grocery stores charge b over w. Then the profit of milk processors is:

$$\Pi = (w - mc)Q(w + b)$$

The first order conditions are

$$\partial\Pi/\partial w = Q(w + b) + (w - mc)\,\partial Q(w + b)/\partial w = 0$$

or

$$Q(p) + (w - (c + b))\,\partial Q(p)/\partial w = 0$$

Therefore, by redefining manufacturers' marginal costs to be c+b in the constant margin case and c(1+b) in the constant markup case, retail prices can be used instead of wholesale prices.

The study on brand competition among saline crackers by Slade (1995) gives a rationale for the assumption of non competitive pricing strategy of grocery stores[22]. She interviewed grocery-chain marketing managers and found that most households shop at the same store each week and their choice of store is determined by location and the quality of the store rather than the pricing policies of the store. Therefore, she finds it is reasonable to assume that competition is among brands within a store.

Marginal costs and counterfactual prices are calculated for each city in each week since it is determined that the same grocery chains in different cities have different pricing policies that vary by week. The A.C. Nielsen Homescan data provide a variable that identifies regional markets at quite a disaggregated level, although it is not precisely at the city level. Markets can be divided into two cities: Charlotte and the triangle area, which comprises Raleigh, Durham and Chapel-Hill.

[22] This does not mean that grocery stores fail to compete. Their competition is more through overall pricing policies, freshness of produce, consumer service, etc rather than through individual items.

Compensating variations are evaluated for individual households in a partial equilibrium framework. Following Small and Rosen (1981), the compensating variation can be derived in a closed form equation as shown below.

$$(6) \qquad CV_i = \Delta e = \frac{1}{\alpha_i}\left[ln[\textstyle\sum_{j=1}^{J} exp(V_{ij}^{w}(p_1))] - ln[\sum_{j=1}^{J-1} exp(V_{ij}^{wo}(p_0))]\right]$$

Compensating variation can be decomposed into the variety effect, which is estimated in the second essay, and the price effect as follows:

$$(7) \qquad CV_i = \frac{1}{\alpha_i}\left[ln\left[\textstyle\sum_{j=1}^{J} exp\left(V_{ij}^{w}(p_1)\right)\right] - ln\left[\sum_{j=1}^{J-1} exp\left(V_{ij}^{wo}(p_1^e)\right)\right]\right]$$

$$+\frac{1}{\alpha_i}\left[ln\left[\textstyle\sum_{j=1}^{J-1} exp\left(V_{ij}^{wo}(p_1^e)\right)\right] - ln\left[\sum_{j=1}^{J-1} exp\left(V_{ij}^{wo}(p_0)\right)\right]\right]$$

where $V_{ij} = X_j\bar{\beta} + X_j\sigma u_i + Z_iX_j\theta + \gamma_i(y_i - p_{ij}) + \omega_j$, V_{ij}^{w} is the indirect utility evaluated with organic milk , V_{ij}^{wo} is the indirect utility evaluated without organic milk, $p_1$is the vector of prices of all items after organic milk is introduced into the market, p_1^e is the vector of conventional milk prices at the original equilibrium, and p_0 is the vector of counterfactual prices of conventional milk when organic milk is not introduced into the market.

2) Multi-stage Demand model

The same data set as in the first essay is used for the analysis. The milk products are categorized into 20 segments to construct the multi-stage demand system. The unit of product at the brand level is defined with fat content, flavor, organic and the name of manufacturer while it was defined with UPC in discrete choice model. The products with market share larger than 1% within the segments are selected for analysis. As a result, 58 products and 16 firms, which account for 97% of retail sales in this region, are subject to the analysis. Unlike the analysis with the discrete choice model, it is assumed that supermarket labeled products are consolidated and produced by a single firm. This might be a strong assumption, but a moderate degree of aggregation was inevitable to avoid dimensionality problem since, without aggregation, there are many products with small market shares in each group.

Since the data for marginal costs are not available at the individual firm/processor level, marginal costs are estimated by solving Equation (3) as described above for the discrete choice model. The derivatives of shares with respect to prices are computed with the elasticity estimates from the demand analysis. Unfortunately, the estimated marginal costs have negative values when they are estimated based on three types of models: Bertrand Nash oligopoly model, where each firm maximizes the combined profits of all products within the firm; and Bertrand Nash oligopoly model, where individual firms maximize the profits of single products; and the collusion model. The analysis could not proceed to the next step with unreasonable marginal costs estimates. Instead, some possible alternative approaches are discussed in this section for future study.

In general, most studies in empirical Industrial Organization employ the Bertrand model assuming constant marginal costs when they analyze the competition among firms at the brand level. This is the most reasonable setting for differentiated goods industry since the main competition at the firm level is in pricing given the product characteristics that differentiate one good from the others. However, constant marginal cost might not be the most reasonable assumption. Although no firm level data on marginal costs are available in dairy industry, it is possible that the dairy processors produce fluid milk at decreasing marginal costs if there are economies of scale in this industry. Blinder's (1991) interview study may cause one to wonder if marginal costs are not constant. He interviewed 200 firms in the northeastern United States to find whether and why prices are sticky. To the question of how their variable costs of producing additional units behave as output rises, only 42 percent of the sample answered that their MC was constant.

The Cournot model can also be considered as an alternative model. Although the Cournot model is known to be applicable only in the context of homogeneous goods, it can still be employed in the heterogeneous goods industry under certain conditions. Hoernig (2003) proves that under horizontal differentiation Cournot equilibria exist if firms react to a rise in competitors' output in such a way that their market price does not rise and there exists a unique equilibrium if some additional weak condition is added. Also, Hovhannisyan and

Gould (2011) extended the New Empirical Industrial Organization (NEIO) approach to the brand level market power study following Hyde and Perloff (1998) where the market power of each product within a separable group is estimated simultaneously employing the conjectural variation in the NEIO approach. These studies adopt the conjectural variation model for the analysis of brand level competition in the same manner as Hausman and Leonard (2002) adopt the multistage budgeting approach for the brand level demand analysis. In this light, Cournot model or other types of imperfect competition models that determine the quantity of output can be applied in the differentiated goods market where the price for each product varies.

Finally, the consolidation of various private labels into one grocery brand might be restrictive. At the cost of a large number of parameters to estimate, different private labels and their ownerships can be accounted for in the model and it may improve the results of estimating marginal cost.

V. Results

In order to exam whether the assumed model of competition is correct, marginal costs are estimated for both collusion and Bertrand-Nash oligopoly models in a discrete choice context. The estimated marginal costs under the collusion model have negative values while the estimates show reasonable values under the oligopoly assumption. Therefore, Bertrand-Nash model is chosen for further analysis although other types of oligopoly models, such as single product profit maximization, Cournot and Stackelburg models, are not examined[23].

[23] Other studies of new product introduction, such as ready-to-eat cereal and bath tissue, examine other types of oligopoly model by comparing the real prices of existing products prior to the introduction and the counterfactual prices since the pre-introduction price data are available and the time of introduction is clearly observable. However, organic milk products are gradually introduced into the market over decades, thus it is hard to recognize the exact time of introduction although organic milk data are available from 2004 in this region according to the A.C. Nielsen data. Given the history of organic milk introduction in the U.S. market, it is difficult to conclude whether the data availability is due to the timing of introduction or the timing of data collection. Under this circumstance, comparing prices before and after 2004 will not provide an appropriate implication on the competition model specification.

Utilizing the estimated marginal costs, the first order conditions are solved again for the counterfactual prices of conventional milk when organic milk is not introduced. Table III-1 and Table III-2 present the median current and counterfactual prices in Charlotte and Raleigh-Durham-ChapelHill (RDU), respectively. The last columns of the tables indicate that overall milk prices are decreased after the organic milk introduction. This can be interpreted as increased competition in the market due to the new product. The average change is larger in RDU than in Charlotte, and the number of items whose prices are decreased is larger in RDU. Pricing policies on individual items are mixed across the cities and the firms. For example, firm A lowered the prices of most items that it sells in Charlotte but raised the prices in RDU after the organic introduction. On the other hand, firm B and firm C raised the prices for most of its items sold in Charlotte while they decreased prices in RDU. Firm F, which is the firm introduced organic milk, also shows different pricing strategies in two cities. It lowered the prices of items sold in RDU, but raised the prices in Charlotte. The pricing strategy in Charlotte shows cannibalization effects in which the new product introducer raises the prices of existing brands to promote the sales of new product. However, note that firm F decreased the price of the most popular brand among its brands[24].

The price effect that is the second part of the equation (7) is evaluated with the estimated counterfactual prices. The results imply that non-organic purchasers in this region benefit about $4,048 from the enhanced competition in fluid milk market. This is equivalent to 3.47% of milk expenditure in this data set. Together with the variety effect whose estimate was $4,591 from the previous chapter, total consumer welfare translated is $8,639 and it is 7.41% of the expenditure in this data set.

This study does not provide the welfare analysis of manufacturers, but some intuitions can be gained by observing the changes in individual firms' margins. Table III-3 and Table III-4 report the estimated marginal costs and the margins of individual items sold in Charlotte and RDU, respectively. The post-introduction margins indicate that fluid milk is a high profit industry with the average margins of 57% in RDU and 62% in Charlotte. The

[24] Brand ID is assigned in the order of market share.

estimated margins seem realistic given that the average conventional milk price is about $3.6 per gallon and the wholesale price is about $14.4 per cwt, which is equivalent to $1.2 per gallon. It is notable that the price-cost margin of organic milk is less than the industry average. Some brands produced by firm F and C are ranked as highest margins independent from the existence of organic milk. The estimated marginal costs are larger and the price-cost margins are smaller in Charlotte than in RDU, but it does not necessarily mean that firms make less profit in Charlotte because the quantity sold is larger in Charlotte. The last columns of the table indicates that, upon introduction of organic milk, the margins of conventional milk brands decreased in both cities although the changes are greater in RDU than in Charlotte. Decreased margins imply that the prices are decreased while marginal costs are constant regardless of whether organic milk is sold. However, the decrease in margins does not mean that profits are reduced since the quantity changes after the introduction of organic milk are not known.

VI. Conclusion

In this chapter I quantify how the introduction of organic milk changes non-organic consumer welfare. The supply-side approach is incorporated with price sensitivity from the demand analysis to approximate competition in the fluid milk market. Marginal costs are estimated assuming that multiproduct firms compete in a Bertrand-Nash fashion where the firms choose prices to maximize profits. The discrete choice approach fits well for the Bertrand-Nash equilibrium, while the multistage demand system approach results in somewhat unreasonable marginal cost estimates for both Bertrand-Nash and collusion models. Thus, the price effect is only calculated for the discrete choice model. The results indicate that the benefits from price changes in conventional milk prices are similar to the benefits from having additional brands and products to choose from, estimated to be approximately 3.5%~4.0% of the current milk expenditure.

Unreasonable marginal cost estimates do not necessarily indicate a failure of any of these approaches since alternative models of competition may describe the market better, although Bertrand-Nash competition is the most commonly used model to approximate differentiated goods market. The multi-stage demand approach is more appealing in its flexibility compared to the discrete choice modeling approach. First, it is closer to classical demand models that are summarized in fairly flexible functional forms. As a result, it is more data dependent than the discrete choice model which relies more on the structure and quite restrictive assumptions of the linear utility model. The discrete choice model assumes that consumers choose no more than one good, although reality is that many households purchase more than one brand of milk at a time. In principle, the mixed logit model introduces flexibility in estimation and has been extended to approximate many choice situations, However, the recovered distribution of heterogeneity might be quite restrictions and the model might be very close to the logit model (Nevo, 2010). Discrete choice approach also has some relative advantages in analyzing household level demand for differentiated goods. Unlike the neo-classical approach, the model accommodates heterogeneous consumer tastes and unobserved attributes of products without dimensionality and missing value problems.

It is difficult to conclude that one of these approaches is superior to the other because the advantage of each model comes at a cost. The multi-stage demand approach adds flexibility to capturing substitution among goods at the cost of large dimensionality. The discrete choice approach comes with the ability to include a large number of goods, but at the cost of lost flexibility in substitution among goods. The choice of which model to use should depend on the particular application and the purpose of study. Clearly, for many applications the multi-stage demand approach can be used to gain insight into substitutability among different disaggregated goods.

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Table III- 1 Predicted Price Change in Raleigh, Durham and Chapel-Hill, median values

Item	Firm	Size	Fat	Counterfactual	Actual Price (post intro)	Change After Introduction
1	A	1	2	3.65	3.83	0.19
4	A	1	3	3.82	3.85	0.03
5	A	1	0	3.84	3.85	0.01
7	A	2	2	5.26	5.29	0.02
10	A	2	3	5.32	5.24	-0.07
13	A	1	1	3.84	3.84	0
25	A	2	1	6.25	5.18	-1.07
26	A	2	0	5.35	5.3	-0.05
3	B	1	0	3.85	3.98	0.13
8	B	2	2	5.23	5.38	0.15
15	B	1	2	3.99	3.92	-0.07
19	B	2	0	5.41	5.38	-0.03
21	B	1	1	3.96	3.89	-0.07
30	B	2	3	6.22	5.38	-0.84
35	B	2	1	5.43	5.38	-0.05
38	B	1	1	6.09	3.9	-2.19
6	C	1	2	3.19	3.35	0.16
9	C	1	0	3.03	2.92	-0.11
14	C	1	3	3.3	3.3	-0.01
23	C	1	1	3	3.08	0.08
29	C	2	0	3.62	3.51	-0.11
32	C	2	2	3.96	3.96	0
40	C	2	3	4.44	4.29	-0.15
11	D	1	2	2.96	2.89	-0.07
17	D	1	0	2.87	2.79	-0.08
33	D	1	3	3.1	3.02	-0.09
12	E	1	2	3.48	3.45	-0.03
22	E	1	0	4.98	3.41	-1.56
24	E	1	3	3.49	3.24	-0.25
28	E	2	2	6.14	4.43	-1.71
16	F	1	3	3.28	3.13	-0.14
18	F	1	0	2.52	2.45	-0.07
20	F	1	2	2.59	2.67	0.08
27	F	1	2	3.3	2.99	-0.31
34	F	1	3	4.94	2.97	-1.97
31	G	1	2	3.73	3.85	0.12
36	G	1	3	3.77	3.85	0.08
37	G	1	1	3.71	3.89	0.18
39	G	1	0	3.67	3.85	0.18
41	Outside	1.5	1.6	4.68	4.04	-0.64
Average				4.13	3.87	-0.26

Table III- 2 Predicted Price Change in Charlotte, median values

Item	Firm	size	fat	Counterfactual	Actual Price (post intro)	Change After Introduction
1	A	1	2	3.67	3.62	-0.05
4	A	1	3	3.69	3.64	-0.05
5	A	1	0	3.59	3.6	0
7	A	2	2	5.02	4.93	-0.09
10	A	2	3	4.95	4.92	-0.03
13	A	1	1	3.62	3.62	0
25	A	2	1	5.03	4.97	-0.05
26	A	2	0	4.97	4.92	-0.05
3	B	1	0	3.84	3.83	-0.01
8	B	2	2	5.05	5.12	0.08
15	B	1	2	3.79	3.85	0.06
19	B	2	0	5.07	5.13	0.06
21	B	1	1	3.82	3.87	0.05
30	B	2	3	5.07	5.01	-0.06
35	B	2	1	4.99	5.14	0.15
38	B	1	1	3.87	3.9	0.02
6	C	1	2	3.22	3.2	-0.03
9	C	1	0	2.92	2.96	0.04
14	C	1	3	3.3	3.29	0
23	C	1	1	2.99	2.96	-0.03
29	C	2	0	3.5	3.49	-0.01
32	C	2	2	3.88	3.92	0.04
40	C	2	3	4.17	4.2	0.04
11	D	1	2	2.93	2.93	0
17	D	1	0	2.84	2.85	0.01
33	D	1	3	3.01	3	-0.02
12	E	1	2	3.28	3.26	-0.02
22	E	1	0	3.2	3.15	-0.05
24	E	1	3	3.38	3.44	0.05
28	E	2	2	4.35	4.34	-0.01
16	F	1	3	3.31	3.22	-0.09
18	F	1	0	2.35	2.42	0.07
20	F	1	2	2.71	2.72	0.01
27	F	1	2	3.25	3.28	0.03
34	F	1	3	2.96	2.97	0.01
31	G	1	2	3.65	3.63	-0.03
36	G	1	3	3.54	3.64	0.1
37	G	1	1	3.54	3.53	-0.01
39	G	1	0	3.61	3.6	-0.01
41	Outside	1.5	1.6	4.56	4.08	-0.48
Average				3.76	3.75	-0.01

Table III- 3 Marginal Costs in Raleigh, Durham and Chapel-Hill, median values

Item	Firm	Marginal Cost (MC)	Margins w/ organic	Margins w/o organic	Changes in Margin
1	A	1.2	68.28	67.1	1.18
4	A	1.39	65.15	63.55	1.6
5	A	1.43	63.58	62.92	0.65
7	A	2.75	48.61	47.74	0.87
10	A	2.8	46.59	47.33	-0.74
13	A	1.42	62.3	62.97	-0.66
25	A	3.74	26.02	40.22	-14.2
26	A	2.84	36.48	46.89	-10.41
3	B	1.62	53.07	57.96	-4.89
8	B	2.95	31.92	43.65	-11.72
15	B	1.79	44.83	55.19	-10.37
19	B	3.12	30.31	42.29	-11.98
21	B	1.77	41.34	55.13	-13.79
30	B	3.94	21.69	36.6	-14.91
35	B	3.17	29.67	41.57	-11.9
38	B	3.89	1.09	36.08	-34.99
6	C	0.96	70.66	69.78	0.88
9	C	0.8	73.28	73.64	-0.36
14	C	1.04	66.25	68.42	-2.17
23	C	0.77	64.67	74.32	-9.65
29	C	1.45	38.21	59.87	-21.66
32	C	1.81	41.6	54.3	-12.7
40	C	2.26	27.22	49.05	-21.83
11	D	0.9	40.93	69.7	-28.77
17	D	0.81	55.01	71.81	-16.79
33	D	1.04	52.54	66.54	-13.99
12	E	1.41	35.94	59.47	-23.53
22	E	2.96	31.64	40.46	-8.82
24	E	1.45	37.25	58.56	-21.3
28	E	4.14	21.67	32.61	-10.94
2	F	3.04	49.14	N/A	N/A
16	F	1.06	59.97	67.56	-7.59
18	F	0.33	89.47	86.9	2.57
20	F	0.39	76.94	84.98	-8.04
27	F	1.12	57.82	66.21	-8.39
34	F	2.74	35.72	44.47	-8.75
31	G	1.68	54.59	54.92	-0.33
36	G	1.72	55.23	54.32	0.92
37	G	1.66	49.32	55.18	-5.86
39	G	1.62	48.83	55.88	-7.05
41	Outside	1.45	63.99	68.94	-4.95

Table III- 4 Marginal Costs in Charlotte, median values

Item	Firm	Marginal Cost (MC)	Margins w/ organic	Margins w/o organic	changes in margin
1	A	1.28	64.66	65.13	-0.47
4	A	1.29	64.68	65.17	-0.49
5	A	1.2	66.5	66.48	0.02
7	A	2.53	48.63	49.55	-0.92
10	A	2.47	49.9	50.16	-0.26
13	A	1.23	66.1	66.1	0
25	A	2.55	48.69	49.23	-0.54
26	A	2.5	49.16	49.73	-0.56
3	B	1.61	58.07	58.13	-0.06
8	B	2.71	47.16	46.36	0.8
15	B	1.57	59.25	58.63	0.62
19	B	2.74	46.55	45.95	0.6
21	B	1.59	58.79	58.3	0.49
30	B	2.72	45.73	46.35	-0.62
35	B	2.68	47.86	46.27	1.59
38	B	1.65	57.74	57.49	0.25
6	C	1.01	68.38	68.65	-0.27
9	C	0.71	75.97	75.61	0.36
14	C	1.08	67.23	67.26	-0.03
23	C	0.77	73.87	74.16	-0.29
29	C	1.34	61.73	61.84	-0.11
32	C	1.71	56.48	56.01	0.47
40	C	1.99	52.77	52.37	0.4
11	D	0.85	70.85	70.87	-0.03
17	D	0.77	73.08	72.99	0.09
33	D	0.93	68.79	68.95	-0.16
12	E	1.19	63.38	63.56	-0.17
22	E	1.13	64.2	64.77	-0.57
24	E	1.3	62.2	61.62	0.59
28	E	2.3	46.89	46.99	-0.1
2	F	3.04	49.81	N/A	N/A
16	F	1.1	65.7	66.68	-0.98
18	F	0.15	93.68	93.48	0.2
20	F	0.5	81.6	81.53	0.07
27	F	1.03	68.44	68.16	0.28
34	F	0.76	74.56	74.51	0.05
31	G	1.61	55.62	55.92	-0.31
36	G	1.49	59.11	57.92	1.2
37	G	1.49	57.67	57.76	-0.1
39	G	1.56	56.57	56.67	-0.09
41	Outside	1.47	63.99	67.76	-3.77