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Got Organic Milk? Consumer Valuations of Milk Labels after the Implementation of the USDA Organic Seal

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Abstract

This paper investigates consumer reactions to changes in information provision regarding organic production. Quantitative analyses focus on the actual implementation of mandatory labeling guidelines under the National Organic Program. The unique nature of the fluid milk market in combination with these regulatory changes allows us to place a value on information sets under different labeling regimes. Hedonic price functions provide an initial reference point for analyses of individual responses. A random utility discrete choice model serves as the primary econometric specification and allows consideration of consumer preference heterogeneity along observable household demographics. Our results indicate that the USDA organic seal increases the probability of purchasing organic milk. An initial hedonic price function approach, as well as simulations within the discrete choice framework, suggests that consumers value the change in labeling regulations with regard to organic production. Our results further suggest that consumers substitute away from milk carrying the rBGH-free label. This may indicate that consumers pay less attention to these labels in the time period investigated compared to results found in studies that use earlier time periods.

KEYWORDS: demand, welfare, product characteristics, organic

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1. Introduction

The implementation of the USDA organic seal under the National Organic Program (NOP) is just one example of health, environmental and ethical claims increasingly being used in a variety of markets, both as marketing tools and regulatory mechanisms. There is a current need for market research into consumer demand for these specialty foods and into the effect of government labeling policy on consumer demand. The widespread use of these labels might be an indication that they are perceived as a successful tool of altering consumer behavior however, availability of information does not necessarily ensure that it will be incorporated into consumer behavior (e.g. Mathios, 2000; Ippolito and Pappalardo, 2002; Jin and Leslie, 2003; Teisl, Bockstael and Levy, 2001; Ippolito and Mathios, 1995). This research provides an ex post cost benefit analysis of changes in labeling regulations under the National Organic Program (NOP), essential for an evaluation of this program. But it might also serve as a benchmark for further government regulations of the growing demand of related specialty foods, such as proposed guidelines for natural products currently under consideration and the ongoing debate about appropriate labeling regarding genetic modification in food products.

The implementation of the NOP in October 2002 with its national organic standard, mandatory labeling guidelines and uniform USDA organic seal has created a quasi-natural market level experiment in a policy-relevant setting. This change in information, isolated from consumers' reactions to changes in product attributes, allows us to provide both an empirical analysis of consumers' willingness to pay for those informational changes and a comparison to the cost of implementing them. By focusing on the complimentary character of product labeling with actual products attributes, we can take advantage of the literature on welfare analysis of new product introduction and provide an innovative approach for analyzing information changes in a utility consistent framework. The specific research questions addressed are threefold: (i) What is the impact of the NOP and changes in information provision on consumer preferences for organically produced milk? (ii) Do these effects vary across consumer segments based on heterogeneous preferences and heterogeneous information costs? And finally (iii) How much are consumers willing to pay for these regulatory changes and how are benefits distributed across consumers?

Our empirical analysis is focused on the fluid milk market. Milk is often considered a gateway to organic food, and the ethos of organic milk—pure goodness, happy cows and small family farming—is heavily reinforced on its cartons via marketing claims. Fluid unflavored milk can be viewed as a relatively standardized and ubiquitously processed commodity, which permits abstracting from brand and taste preferences. It allows investigating consumer preferences for privately certified rBGH-free labeled milk[1], third party and government certified labeled organic milk, and conventional milk.

Previous empirical studies of the effects of voluntary and/or of mandatory product labeling in the food sector have tended to focus on the provision of nutritional information and exhibit mixed results regarding effectiveness of information provision (see, for example Ippolito and Mathios, 1990; Mojduszka and Caswell, 2000; Ippolito and Mathios, 1995; Mathios, 2000; Teisl, Bockstael and Levy, 2001). Evaluating eco-labels, Teisl, Roe and Hicks (2002) report that dolphin-safe labels resulted in changes in aggregate tuna consumption, and Jin and Leslie (2003) conclude that consumer demand is sensitive to mandatory and voluntary display of hygiene quality grade cards in the Los Angeles restaurant market. In terms of empirical studies of consumer level responses to related advertising, Ackerberg (2001) finds responses by inexperienced buyers.

The existing literature on how consumers respond to labeling claims regarding organic and genetically modified food production is dominated by attitudinal surveys, choice experiments and experimental auctions (see Marks, Kalaitzandonakes and Vickner, 2003 for an overview; Roe and Teisl, 2007; Huffman et al, 2003; Batte, Beaverson and Hooker, 2003). Results range from substantial price premiums and distinct consumer segments to no avoidance behavior or detectable effects. Roe and Teisl (2007) combine differences in non-GMO labeling information with variation in agencies that certified these claims. They find that simple claims are viewed as most accurate, and labels certified by the US Food and Drug Administration (FDA) are perceived as more credible than third party and consumer organization certification. For some types of labels such as reduced pesticide use, USDA certified claims are viewed similarly credible. While Batte et al (2003) find that the willingness to pay for organic content post NOP varied with income and other demographics such as age and education, Huffman et al (2003) find that household demographics had no significant effect on willingness to pay for non-genetically modified products in experimental auctions of products displaying divergent labeling claims. Careful design and statistical analysis in survey responses can minimize but not eliminate strategic and hypothetical bias. Experimental studies rely on a much more limited range of items than available in actual retail stores. In addition, participants may exhibit what is called the Hawthorne effect, an increased bidding amount to please the experimenter. And finally, these approaches cannot be readily applied to a random sample of the population.

Empirical studies of informational effects of the use of rBGH and organic production on milk demand have mainly been limited to the analysis of survey responses (e.g. Grobe and Douthitt, 1995; Misra and Kyle, 1998) and market

[1] Recombinant Bovine Somatotropin, is a genetically modified version of a growth hormone that occurs naturally in cows and is injected to enhance milk production by 10 to 15%.

based research focuses on the actual production attributes. Aldrich and Blisard (1998) utilized monthly pooled time-series and regional data for 1978 through 1996 to examine whether the use of rBGH and consumer concern reduced aggregate fluid milk consumption, but found no evidence of such an effect. Focusing on organic milk, Glaser and Thompson (2000) identified price premiums as high as 103%, and high own-price elasticities for organic milk products. Dhar and Foltz (2005) used a quadratic, almost ideal demand system (AIDS) for differentiated milk types in combination with supermarket scanner data. They found significant consumer valuation of organic milk, and to a lesser extent, rBGH-free milk. Following a different approach and focusing on product attribute uncertainty faced by the consumer and his/her search costs addressed in a random utility framework, Kiesel, Buschena and Smith (2005) reported similar findings. In addition, by identifying rBGH-free labeled and unlabeled products, their results suggest that the provision of relevant information on a label might be required if market segmentation is to take place. Our paper adds to the literature as it provides a direct market approach and presents consumer valuation estimates of different labeling regimes based on actual purchases.

A unique data set is utilized in this study. AC Nielsen Homescan® data tracks individual purchases by participating households across all chosen food channels and provides household demographics. Taking advantage of these unique data we are able to access consumer valuation of the NOP in an initial hedonic price function approach (Rosen, 1974), as well as in a discrete choice model (McFadden, 1974; Train, 2002) approach.

In our analysis of information changes, we follow the literature on welfare estimations of new product introductions (e.g. Bresnahan, 1997; Hausman, 1997; Hausman and Leonard, 2002; leading to a variety of empirical papers such as Nevo, 2003; and Kim, 2004).[2] In this context, we define product specific information provision via labels as additional or differentiated product attributes. We further define the consumer product as a bundle of perceived product attributes, which allows us to compute consumer's willingness to pay for additional labeling information in a straightforward way. The utilized discrete choice model (e.g. Berry, Levinsohn and Pakes, 1995; McFadden and Train, 2000; Nevo, 2000; Nevo, 2003; Swait *et al,* 2004) also offers flexibility in incorporating consumer heterogeneity with regard to organic production. The estimates of willingness to pay for the labeling change are based on counterfactual

[2] In addition, a number of theoretical analyses directly address the effects of product labeling on consumer demand by modeling the decision-making process using generalized Lancaster demand models or hedonic (Houthakker-Theil) demand models based on product attributes (e.g. Smallwood and Blaylock, 1991; Caswell and Padberg, 1992; Teisl and Roe, 1998; Teisl, Roe and Hicks, 2002; Golan, Kuchler, and Mitchell, 2000).

simulations of restricted choice sets, and changes in consumer surplus are computed (Small and Rosen, 1981).

Our findings indicate that the display of the USDA organic seal on a milk carton increased the probability of purchase during the time period under consideration. And both the hedonic price function approach and simulations using conditional logit regressions suggest that consumers value the changes in labeling regulations under the NOP. In addition, our results suggest that consumers substitute away from milk carrying the rBGH-free label, possibly because consumers pay less attention to these labels in the time period investigated compared to results found in studies that use earlier time periods.

The paper proceeds as follows. In the next section, we describe the market for organic milk and the data are described in section 3. Section 4 outlines the econometric modeling approach, while section 5 presents the empirical results. The paper concludes in section 6 and discusses implications for future research.

2. The Market for Organic Milk

Our empirical analysis is centered on the fluid milk market. The fluid milk market offers a variety of differentiated products across categories, such as privately certified rBGH-free labeled milk; third party and government certified labeled organic milk, and conventional milk. At the same time, fluid unflavored milk is a relatively standardized and ubiquitously processed commodity, which permits abstracting from brand and taste preferences in general to take advantage of this rich product differentiation, as demonstrated in Figure 1 and 2, depicting observed product and brand choices of panel members in the data set analyzed in this paper.

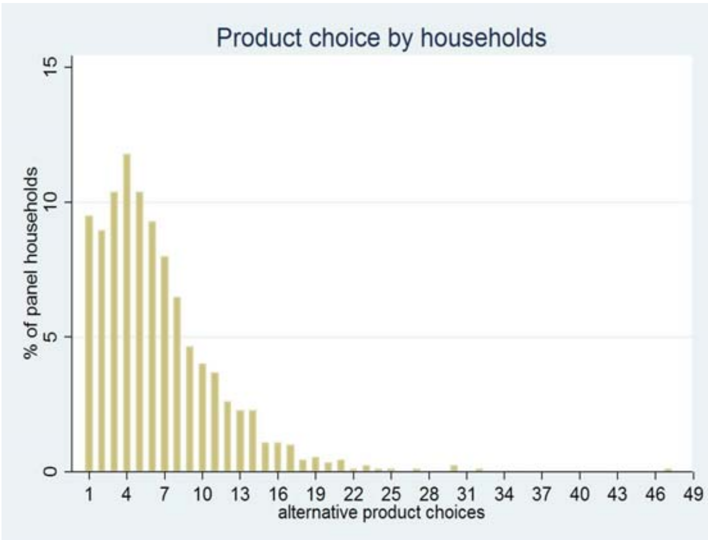

Figure 1: Alternative product choice by panel members

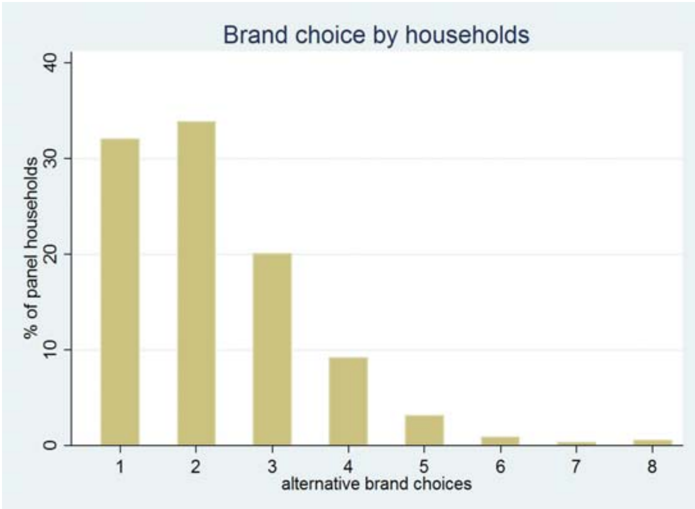

Figure 2: Alternative brand choice by panel members

While still a niche market, the U.S. organic market is one of the fastest-growing categories in food business. Organic products as a whole are projected to reach a value of $30.7 billion by 2007, with a five-year compound annual growth rate of 21.4 percent between 2002 and 2007 (according to Organic Trade Association, 2006). Nearly two thirds of U.S. Consumers bought organic foods and beverages in 2005, up from about half in 2004 (Consumer Reports, CR, 2006). Organic products sell at a significant price premium (50% on average) compared to their conventional counterparts with prices often doubling for milk and meat (CR, 2006). These price premiums and market trends sparked an interest in organic production among large food companies in recent years.[3] *General Mills*, *Kraft*, *Dean Foods*[4], and *Dannon* already market or own many of the branded organic products, and some supermarkets such as *Safeway*, *Kroger* and *Costco* offer organic store brands. Most recently, *McDonald's* and *Wal-Mart* entered the playing field in an attempt to milk the "organic cash cow" (*The New York Times,* 11.1.2005, 11.9.2005). As organic food products went mainstream, the debate over what organic really means is still ongoing. For instance, two recent debates include approval of artificial ingredients and industrial chemicals such as boiler additives, disinfectants and lubricants, as well as stricter requirements for access to pasture in organic dairy production. This paper focuses on changes in information provision that relate to the implementation of the NOP

[3] One could even argue that the NOP induced this take-off, as well as overall changes in industry structure.
[4] For instance, *Dean Foods* bought out *Horizon Organics* in June 2003.

in October 2002. The program included a uniform national standard, new labeling guidelines and the appearance of a USDA organic seal on organic products.

The NOP was initiated as a direct consequence of the Organic Foods Production Act in the 1990 Farm Bill, calling for regulations of production, handling and marketing of organically produced agricultural products under the management of the U.S. Department of Agriculture (USDA). While the regulatory changes were long anticipated and the USDA considered over 275,000 public comments after their first proposal in 1997, and over 38,000 comments after their revised rule in 2000, the initiation precedes much of the industry growth and controversy. This is especially true for organic milk. While organic foods trace back to the natural foods movement of the 1960's, organic milk has only been available for a little more than a decade. But organic milk sales have been one of the fastest growing market segments ever since as "people who don't buy any other organic products are purchasing organic milk" (DiMatteo, OTA in DuPuis, 2000). This rapid growth of organic milk is often linked to the controversy about the use of the genetically modified growth hormone rBGH and its wide media coverage (DuPuis, 2000). Ongoing health and safety concern by some consumers are at the heart of this controversy as approximately 35% of the U.S. dairy herds, about 9 million dairy cows, currently receive rBGH supplements that increase milk production by 10 to 15% (Monsanto, 2006). Milk from treated cows is not subject to any labeling requirements since the FDA has determined it to be safe and not significantly different from milk from non-treated cows, an opinion that is also shared by the Center for Disease Control. Voluntary labeling for milk products that come from untreated cows is used by dairy processors to address these concerns by consumers, but is required to be accompanied with a disclaimer citing the lack of scientific evidence for differences between milk produced with and without rBGH. This controversy was also the birth place of the ongoing "Milk is Milk—The Simple Truth" campaign initiated by the Center of Global Food Issues (CGFI) and its coalition[5] in hopes of ending the battle over appropriate milk labeling for hormone, antibiotic, and pesticide use in production-oriented claims. The campaign focuses on the many claims found on milk cartons today, such as: "Produced without the use of dangerous pesticides, added growth hormones or antibiotics," "our cows make milk the natural way," and "a clean-living cow ... makes really good milk." The media attention regarding rBGH and marketing claims that still appear on milk cartons, in addition to the uniform USDA seal, illustrate the need of addressing policy evaluation in the context of other sources of information. One interesting feature of the milk market is that product, or brand specific advertising or marketing claims, mainly target container

[5] The CGFI campaign is supported by the Center for Science in the Public Interest, the Federal Trade Commission, the National Consumers League, and the U.S. Food and Drug Administration (FDA).

design. Comparison of organic milk containers before and after the appearance of the USDA seal suggests that advertisement and marketing claims did not change over the investigated time period.[6]

In addition, we address consumer heterogeneity regarding complex organic production attributes in general. “Organic food is produced by farmers who emphasize the use of renewable resources and the conservation of soil and water to enhance environmental quality for future generations,” (USDA, NOP, 2002). Therefore, it is not directly linked to other commonly analyzed food demand dimensions and consumer preferences for these attributes are not well understood. Some consumers buy organic products to support its producer’s environmentally friendly practices, but most are trying to cut their exposure to chemicals and other unwanted ingredients such as genetically modified ingredients (CR, 2006).[7] *Horizon Organic*, the leading organic milk brand, describes its consumers as “concerned about toxic pesticides, growth hormones and antibiotics in their food and in the environment, and place[ing] value on animal welfare and ecological sustainability.” And for the second largest brand, *Organic Valley*, these targeted “cultural creatives” represent nearly one-quarter of the population, potentially capturing a large segment of the total fluid milk sales that amounts to $11 billion. But for Nobel laureate agronomist Norman Borlaug and others, the claim that organic is better for human health and the environment is not even worth a debate as “you couldn’t feed more than 4 billion people … and would have to increase cropland area dramatically, spreading out into marginal areas and cutting down millions of acres of forest…If some consumers want to believe that it’s better from the point of view of their health …let them pay a bit more,” (*The Wall Street Journal*, 8.26.2002). He is referring to the conundrum that taste and health concerns are consistently determined as primary purchase motivations when it comes to organic food consumption (e.g. McEachern and McClean, 2002), despite missing scientific evidence on enhanced nutritional value, health benefits for the consumer and animal welfare (Williams, 2002; Roesch, Doherr and Blum, 2005).[8] “Food is an emotional issue” says Elizabeth Whelan of the American Council on Science and Health (*The Wall Street Journal,* 10.25.2002). While “the very presence of the [USDA organic] stamp is going to increase awareness that there is something different called

[6] Of course, the added USDA seal could be viewed as a validation or reinforcement of these claims.

[7] Another often discussed consideration could be support of small farming. While support for small farms is advertised on organic milk cartons, the organic dairy sector is often more concentrated and vertically integrated than its conventional counterpart.

[8] Some research suggests higher levels of vitamin E, omega 3 essential fatty acids and antioxidants in organic milk, relative to conventionally produced milk (e.g. Soil Association, 2005), and nutritionists point out that people are likely to meet their dietary needs for these nutrients by consuming other foods (e.g. Nugent, British Nutrition Foundation, in BBC News, 2005).

organic," and probably boost sales, as *Horizon Organic* Chief Executive Chuck Marcy (*The Wall Street Journal,* 9.11.2002) puts it, the question remains how and why.

3. The Data

The data set used in this study was extracted from AC Nielsen Homescan© household panel data that track household purchases in 52 markets nationwide over a time period of four years (2000-2003). This data set is unique in that it tracks individual purchases of its participating households across all marketing channels, and provides detailed household demographics. For any reported product purchase, information on price and price promotions such as sales and coupon use, as well as detailed product attributes, are available. The data include a separate indicator for organic claims and the USDA organic seal. Lactose-free and kosher milk products are also identifiable in the data. Information on rBGH-free labeling was not included in the data set and was added at the brand level utilizing a list of rBGH-free products provided by *Rural Vermont and Mothers and Others* combined with information regarding rBGH-free labels provided by the CGFI.[9]

This study focuses on fluid milk, excluding buttermilk, flavored milk, and non-dairy alternatives (such as soy or rice milk) to ensure comparisons of fairly homogeneous products. The major limitation of these data relates to the fact that only the actual choices by a given household are observed. Available product choices at a given store are not available at this point and choice sets need to be constructed based on observed purchases of the panel members in a given market. Even though demand for organic milk is one of the fastest growing market segments it is still a niche market accounting for about 3% of the total US milk sales in 2005 (*The New York Times*, 11.09.2005). Therefore, the analysis focuses on one market only which provides sufficient observed organic milk purchases to construct credible choice sets, as the data set is very limited with regards to observations of organic milk product choices.[10]

[9] This information is currently only available at the brand level.
[10] If no organic purchases are observed, one cannot distinguish between no purchase of organic milk by included panel members and no availability of organic milk in a given store or market at a specific point in time. We are aware of the fact that the selection of a market based on observed organic purchases might introduce bias to our estimation results and will discuss this potential bias when presenting the results.

Table 1: Average Household demographics

Descriptive statistics (household demographics)

	National population *	Selected market population *	Sample data (all households)	Sample data (milk consumption only)
gender (female)	50.9	49.2	66.28	69.21
median age	35.3	39.2	42**	42**
median income	$41,994	$60,031	$55,000***	$55,000***
race				
white	75.1	49.7	61.88	62.36
black	12.3	7.8	14.05	13.88
asian	3.6	30.8	13.79	13.4
other	10	7.4	10.28	10.37
hispanic	12.5	14.1	13.83	15.2
household composition				
household size	2.59	2.3	2.49	2.64
married	51.7	33.38	52.72	57.04
with children under 18	25.7	14.5	30.09	34.4
with children under 6	7.3	4.1	4.18	4.84
number of households			1041	927

* based on 2000 census data
**median age category is 40-42 (age of children not included in derivation for data set)
***median income category is $50000-$59999

Table 1 compares average sample household demographics both for the complete household panel of this market and the subset of households that purchased milk over the relevant time period to market and national population averages reported in the 2000 census. While the selected market exhibits a more diverse race distribution, higher mean income, and fewer married couples and household with children than the national average, the analyzed sample approaches national averages for some of these demographics. It is also worth noting that the sub-sample of households that buy milk does not differ significantly from the entire household sample for this market, with the exception of a slight increase in the number of married couples and households with children, which seems reasonable in the case of milk consumption.

The final data set used in the analysis is restricted to brands that were purchased 20 times or more over the entire time period and stores with at least two observed alternative products at a given month. Furthermore, only half gallon and gallon milk containers, the most common sizes, were considered. The final data set consists of 40.341 daily purchases by 927 households choosing among 182 different milk products (16 brands) in 21 alternative stores.

The analysis focuses on the discrete purchase decision only, although information on purchase amounts is included in the data.[11] Whenever a household

[11] This information is not utilized in a discrete choice framework such that a households inventories and stockpiling behavior is not captured. But this limitation should be less restrictive

purchase was observed in a given store, it was assumed that this product was available to households over the entire month at this store. The minimum observed purchase price at the relevant store was used to construct prices for the alternatives to actual purchases.[12] As we confine the created alternative choices to the store in which the household purchased milk—mainly to ensure feasibility of the data analysis—we implicitly assume that the decision of what store to go to is made prior to deciding which specific milk product to purchase (see Swait and Sweeney, 2000; Ackerberg, 2001 for similar approach). Store fixed effects are included in the first stage or control function approach, however, to account for store level unobserved constant characteristics that may affect prices. Store dummies are also included in some of the logit specifications to account for consumers preferences for certain stores. The resulting complete choice set matches all alternatives purchased by all households' at a given store in a given month with actual choices by a specific household, inflating the data set to a total of 449.879 observations.

Commodity trading prices at the *Chicago Mercantile Exchange* of nonfat dry milk powder and whole milk powder reported in *Dairy Market News* were also added to the data set. Descriptive statistics of the resulting final data set are reported in Table 2.

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for milk due to its relatively short shelf life and the fact that purchased quantities mainly reflect a given household composition (see also Swait and Sweeny 2000, and Ackerberg 2001).

[12] The minimum price rather than a mean or median price is used to capture a specific choice and consumer preferences while accounting for possible sales on alternative milk products. Results do not vary significantly when using either the median or maximum price instead.

Table 2: Descriptive statistics of final data set

Descriptive statsistics (product charcteristics)

	original choices					data including created choice sets				
Variable	Observations	Mean	Std. Dev.	Min	Max	Observations	Mean	Std. Dev.	Min	Max
choice						449879	0.090	0.286	0	1
number of choices at store by month						449879	25.057	7.585	2	40
price (in cents)										
price (adjusted to gallons, using maximum price below)	40341	343.951	130.637	0		449879	448.295	166.667	0	860
price alternative choice (maximum price)						409538	458.574	166.298	0	860
price alternative choice (minumum price)						409538	431.473	174.945	0	858
price alternative choice (median price)						409538	445.701	170.626	0	858
residual from first stage regession	40341	$2.19*10^{-7}$	64.950	-598.32	341.405	449879	$2.46*10^{-7}$	75.954	-589.680	367.848
in store promotion	40341	0.213	0.410	0	1	449879	0.338	0.473	0	1
customer coupon	40341	0.007	0.084	0	1	449879	0.001	0.025	0	1
private label	40341	0.759	0.428	0	1	449879	0.538	0.499	0	1
fat content										
fat free	40341	0.238	0.426	0	1	449879	0.213	0.409	0	1
lowfat	40341	0.543	0.498	0	1	449879	0.249	0.432	0	1
whole	40341	0.219	0.414	0	1	449879	0.538	0.499	0	1
package										
half	40341	0.461	0.498	0	1	449879	0.577	0.494	0	1
glass	40341	0.002	0.045	0	1	449879	0.004	0.066	0	1
carton	40341	0.364	0.481	0	1	449879	0.504	0.500	0	1
labeling characteristics										
lactose free label	40341	0.013	0.114	0	1	449879	0.070	0.254	0	1
no rBST label	40341	0.195	0.397	0	1	449879	0.274	0.446	0	1
organic label	40341	0.043	0.202	0	1	449879	0.159	0.366	0	1
usda label	40341	0.019	0.137	0	1	449879	0.069	0.253	0	1
unit measures (adjusted to gallons)										
product units purchased (per shopping trip)	40341	1.120	0.696	0.5	22					
units of non-organic milk purchased by month	40341	942.404	135.885	628	1103	449879	954.738	124.634	628	1103
units of organic milk purchased by month	40341	25.276	8.051	5.5	38.5	449879	26.084	7.645	5.5	38.5
ratio organic units purchased/non-organic units purchased	40341	0.026	0.006	0.009	0.036	449879	0.027	0.006	0.009	0.036
distribution of observations by year										
2000	7286	0.181	0.385	0	1	62880	0.140	0.347	0	1
2001	11012	0.273	0.445	0	1	119398	0.265	0.442	0	1
2002	11127	0.276	0.447	0	1	138254	0.307	0.461	0	1
2003	10916	0.271	0.444	0	1	129347	0.288	0.453	0	1

4. Econometric Framework

In this section, we describe several aspects of our empirical strategy. A hedonic price function approach provides an initial reference point for estimates of consumer valuation of labeling changes and motivates more flexible discrete choice models. A detailed discussion of the employed logit model and simulations of restricted choice sets follows. And finally, controls for endogeneity of product prices in the discrete choice demand regression specifications are described.

4.1 Hedonic Approach

The hedonic price method (Rosen, 1974) presents an approach often used when estimating consumer valuation of goods or product attributes for which no explicit market exists. It is based on the simple intuition that the utility of differentiated products implicitly allows for the recovery of the contribution of each attribute to the overall utility. The price of a given milk product m_i can be written as $price_{m_i} = price(a_1, ..., a_n)$, where the partial derivative of price(•), with respect to the n^th^ attribute $\partial price / \partial a_n$, defines the marginal implicit price. The hedonic price schedule is determined by interactions between consumers and producers in a given market, such that each point of the schedule represents an individual's marginal willingness to pay for that attribute. We estimate an equation that relates the price of milk to observable attributes of milk products, as well as unobserved product attributes. Estimated parameters recover the average implicit price gradient, or average marginal willingness to pay for each product attribute. In particular, the average willingness to pay for changes in labeling regulations can be estimated directly, as the USDA organic seal can be included as one relevant product attribute. However, regression coefficients capture an average willingness to pay only if preferences are homogeneous across the entire population (e.g. Rosen, 1974; Chay and Greenstone, 2005). If market responses are a result of preference heterogeneity one might only recover an average across subpopulations that sort themselves according to their valuation of specific product characteristics. Estimates in this approach are used only to provide an initial reference point and robustness check for estimation results in the below described discrete choice models that address consumer heterogeneity in more flexible ways. In addition, comparison of estimates in these two approaches can provide empirical support to the recent critique of the hedonic price function approach.

4.2 Random Utility Model and Logit Specification

The unique household panel data set with household-specific purchase information and household demographics for its panel members enables us to consider and estimate a specification of heterogeneous preferences in econometric discrete choice models explicitly. Starting from a random utility framework (e.g. McFadden 1974; and Train, 2002) where both the product attributes as well as a random term are assumed to enter linearly, the utility from consuming a certain milk product can be described as

$$U_i = A_i \beta + r_i \, . \qquad (1)$$

In equation (1), the vector A_i indicates the attributes of milk product m_i, the vector β represents the weights or marginal utility placed on each of these attributes, and r_i denotes remaining randomness or uncertainty. If there are a number of heterogeneous households *(h)* that choose among different milk products *(i)* at different points in time *(t)* then we define the indirect utility as

$$U_{iht} = A_{iht} \beta_{ht} + r_{iht} \, . \qquad (2)$$

Note that the attributes have an additional index h to address possible heterogeneity in attribute perception across households, as in the case of organic production. The vector A_{iht} therefore indicates attributes as perceived by a given household at period t and β_{ht} indicates household-specific weights placed on them. One deviation from the classical random utility model should briefly be mentioned. The classical model assumes that the household observes the product attributes and knows the weights he places on them with certainty. Randomness arises only from the standpoint of the researcher. The specification in this paper varies in that it postulates some unresolved uncertainty in the utility derivation of the household such that the household chooses milk product m_i if :

$$\Pr\left(m_{it}=1\right) \equiv \Pr\left(U_{iht} > U_{jht}\right) \equiv \Pr\left(r_{jht} < r_{iht} + (A_{iht} - A_{jht})\beta_{ht}\right), \qquad (3)$$

for all $i \neq j$.

The product choice of a given household depends on the product attributes as perceived by this household, as well as the marginal value assigned to them. The remaining uncertainty about true product attributes and its potential risks and benefits further determine the household choice. While this household specific random component may not be empirically separable from the additional source of randomness that arises from an econometrician's point of view, due to unobservable household and product characteristics that could influence household choices in the existing models, it is conceptually important. Remaining uncertainty about true product attributes and/or its potential benefits would result in changes in consumer behavior due to changes in information provision and enable a utility consistent estimation of welfare effects. It is important to note that we do not assume that changes in information result in changes in household tastes or preferences. Rather, consumers demand a joint bundle of attributes, such as labeling and advertisement in that these changes are directly related to models of product differentiation and product quality. In this context, information changes could resolve some uncertainty with respect to appropriate monetary valuation of the relevant attributes, might change benefits through prestige or image effects that add value to the consumer, or simply point out attributes previously not recognized. All of these effects could increase or decrease the utility assessment of a specific product and change its ranking relative to other choice alternatives without changing underlying household preferences. This conceptual extension would further allow incorporating behavioral and informational effects such as anchoring and attention focus. Of course, this underlying uncertainty might vary by households such that better informed consumers are less responsive to changes in labeling information and heterogeneity across households is potentially twofold: Households vary according to their underlying preferences for observed product attributes, as well as their informational background and remaining uncertainty.

Redefining the above specifications from the researcher's point of view would result in a replacement of r_{iht} with ε_{iht}, where ε_{iht} now incorporates both sources of uncertainty. It relates the observable part of the stochastic decision-making process of the household to remaining unobservable choice determinants and data problems. Distributional assumptions about this combined error term drive the econometric model choice, but also affect estimation results in a variety of ways.

The logit model estimated in this paper can capture preference heterogeneity if tastes vary systematically with respect to observed variables. Observable household demographics, *D*, are used to account for preference heterogeneity and can be incorporated into the indirect utility formulation as follows:[13]

$$U_{iht} = A_{it}\beta + (A_{it} \times D_h)\gamma + \varepsilon_{iht}. \qquad (4)$$

If ε_{iht} are assumed to be independently, identically extreme value distributed (type I extreme value distribution), the following closed form solution can be derived for the probability that a household's product choice corresponds to milk product m_i:

$$\Pr_{ht}(m_i = 1) = \frac{e^{A_{it}\beta + (A_{it} \times D_h)\gamma}}{\sum_{j=1}^{J} e^{A_{jt}\beta + (A_{jt} \times D_h)\gamma}} \qquad (5)$$

These response probabilities constitute what is usually called the conditional logit model. The underlying distributional assumptions of this specification have some important limitations. The most stringent restriction relates to the independence of irrelevant alternatives property (IIA), as the relative probabilities for any two alternatives depends only on the attributes of those two alternatives due to the iid extreme value assumption such that the ratio of choice probabilities stays the same after the introduction of a new alternative. Analogous to the often used "red-bus-blue-bus" problem (e.g. Train, 2002) one would like to compare the ratio of choice probabilities of organic versus conventional milk before and after the introduction of the USDA organic seal. Due to the nature of our application as a change in information rather than a change in alternatives, we cannot directly compare these choice probabilities. The labeling change actually did not lead to an introduction of new organic products *per se*, instead, some of the existing organic milk products added the label to the milk container and some did not.[14] Using choice probabilities of rBGH-free milk instead—often perceived as a close substitute to organic milk—one might argue that choice probabilities of

[13] Only differences in utility are identified in this model such that household demographics need to be interacted with product attributes. Differences in attribute perceptions cannot be investigated empirically and will enter into the error term.
[14] This finding is discussed in more detail in the results section.

rBGH-free milk are affected more heavily by this change in information provision regarding organic production than choice probabilities of conventional milk. The chosen model would impose the ratio of these choice probabilities to stay the same, however. Nonparametrically comparing choice probabilities prior and post NOP in 2001 and in 2003 respectively, reveals a surprisingly constant probability ratio of 0.247 and 0.245. Related to these stringent substitution patterns imposed by the model is the ability to address taste variation in this model, as the iid extreme value assumption also implies that unobserved factors are uncorrelated over alternatives, as well as having the same variance for all alternatives. This restriction, with regard to heterogeneous consumer preferences not captured by observed household demographics, is relaxed by clustering the estimated error structure by individual households. Overall, we argue that the chosen logit specification seems to be supported by our data, can capture average tastes, and the logit formula has been shown to be fairly robust to misspecification (Train, 2002). The main motivation and advantage of this model choice is a resulting closed-form solution enabling a straight forward overall cost-benefit analysis of the labeling change described in the next section.

4.3 Consumer Valuation

Estimates of changes in consumer surplus (CS) can be derived through simulation of restricted choice sets. They correspond to a household's compensating variation for a change in product attributes (Small and Rosen, 1981) and in our case, a change in information provision about attributes. Given its beliefs and available information set, a household chooses the product alternative that provides the highest stochastic utility. Expected consumer surplus, CS_{nt}, can therefore be defined as

$$CS_{ht} = \frac{1}{\alpha_h} \max_j \left(U_{hjt} \forall j \right), \qquad (6)$$

where α_h denotes the marginal utility of income. The negative of the price coefficient can be used as an estimate of α_h in this formulation. Since the maximum utility is unobservable, the following expected consumer surplus formulation from the researcher's perspective can be specified as

$$E\left(CS_{ht}\right) = (1/\alpha_h) E\left[\max_j \left(A_{jt}\beta + (A_{jt} \times D_h)\gamma + \varepsilon_{jht} \forall j \right) \right]. \qquad (7)$$

If each ε_{iht} is *iid* extreme value and utility is linear in income, then the change in consumer surplus that results from a change in product alternatives or product choices can be computed as

$$\Delta E\left(CS_{ht}\right)=\frac{1}{\alpha_h}\left[\ln\left(\sum_{j=1}^{J}e^{A_{jt}^{1}\beta\;+(A_{jt}^{1}\times D_h)\gamma}\right)-\ln\left(\sum_{j=1}^{J}e^{A_{jt}^{0}\beta\;+(A_{jt}^{0}\times D_h)\gamma}\right)\right]\;, \qquad (8)$$

where the superscripts 0 and 1 refer to prior the change and after the change, respectively. This measure of consumer valuation can be computed using estimated regression coefficients and simulating the counterfactual where labeling changes would have not taken place by restricting the choice set through an exclusion of organic milk carrying the USDA seal. Estimated regression coefficients for the USDA organic seal will be forced to zero in this restricted choice set. This specification, also denoted in the literature as the variety effect can be extended to account for possible price changes in existing products prior to the implementation of the USDA by adding a second term (price effect) that compares pre and post regulation prices of these products (e.g. Kim, 2004). We do not follow this approach as prices over the investigated time period are fairly stable as illustrated in Figure 3.

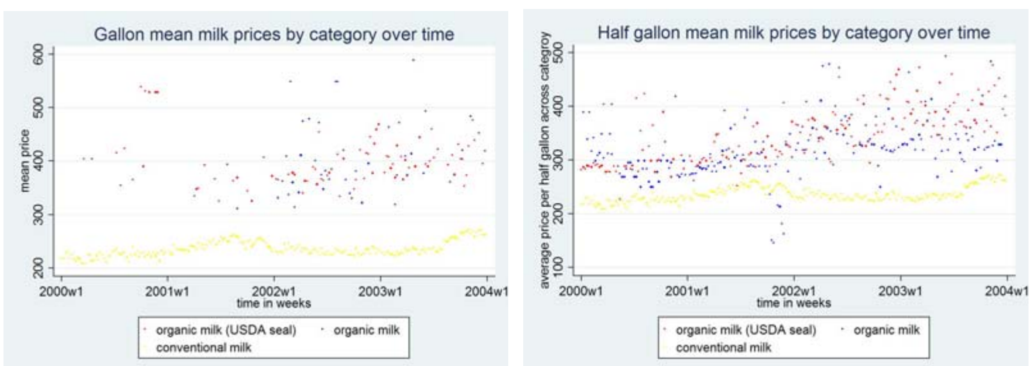


Figure 3: Mean prices across organic categories over time

4.4 Endogeneity Controls

The choice of milk products in this framework is captured as a choice of a bundle of observable attributes including labels and price. But retailers consider all product characteristics when setting prices and account for changes in characteristics, as well as consumer valuation. This introduces a simultaneity problem in that both choice probabilities and prices are affected by unobserved attribute characteristics implying that prices are correlated with disturbances included in the discrete choice demand regressions. Input prices for milk production are used as instruments for prices set by the retailer as it seems reasonable to assume that they are not correlated with unobserved product characteristics and product choice, while raw milk prices account for 62% of retail milk prices (U.S. G.A.O., 2001). Raw milk prices cannot directly be used as they are regulated under marketing orders, support price mechanisms, and do not vary over time. Instead weekly commodity trading prices at the *Chicago Mercantile Exchange* of nonfat dry milk powder and whole milk powder are used as they might capture seasonality and supply shocks as well.[15] Regressing observed milk product prices only on weekly nonfat and whole dry milk powder trading prices, respectively, as a first test and motivation for this instrument choice results in positive (33.19 and 31.71) and statistically significant coefficients at the 5% and 1% significance level. As proposed in Villas-Boas (2007), these input costs (c_t) are then interacted with brand specific fixed effects (B_i) for whole and low fat milk, respectively, to allow for cross-sectional variation by fat content and brand. The resulting set of primary instruments is statistically significant for almost all instruments individually and allows rejecting the hypothesis of joint model misspecification or insignificance from zero at the 1% significance value and F-statistic of 476.18. Store fixed effects (S_i) are also included in the final regression to account for varying operational costs and services by the store and may explain variation retail prices. An indicator of package material (*carton*) is further added to capture possible cost differences in packaging. And finally, observable demand shifters other than price are included as it is assumed that these are exogenous to weekly or monthly pricing decisions as decisions about the offered product mix require long term investment choices. The final regression results in an overall F-statistic of 2789.09 and an R^2 of .75.

Rivers and Vuong (1988) and Villas-Boas and Winer (1999) discuss a two-step approach and more recently Petrin and Train (2004) describe a similar control function approach followed in this study. This procedure also leads to a simple test for endogeneity. The first stage is specified as an OLS regression of the price of product i in week t on the above explanatory variables $p_{it} = S_i + \beta_1 B_i \, \mathrm{c}_t + \beta_1 carton_i + \beta_1 Z_i + \varepsilon_{it}$, and the vector of OLS first stage residuals is then included in the second stage conditional logit estimations to correct for potential bias of the price coefficients due to endogeneity. While this procedure offers a straightforward way of correcting for endogeneity, it also adds another source of scaling. Each coefficient increases in value relative to its un-scaled counterpart, unless price is truly exogenous.[16]

[15] One argument would be that processors usually offer a range of dairy products, while raw milk prices are regulated. Their prices might reflect overall variations in dairy input prices.

[16] In this model, coefficients are estimated relative to the variance of unobserved factors and only the ratio of "original" coefficients over this scaling parameter is estimated. If prices are endogenous and the first stage residual is included in the regression, the variance of the unobservable factors should be reduced.

5. Estimation Results

The first result of this analysis relates to the selection of the market for our detailed analysis. Only the major markets include organic purchases with varying frequency. While we cannot control for availability of organic milk in any of these markets over the time period analyzed, due to unavailable accompanying store level data, it seems to suggest that organic preferences are more developed in urban areas and are less of a concern to households in rural areas. The selection of the market analyzed based on observed organic purchases might also upward bias our reported results if we generalize them for the entire population. Again, our data set does not allow us to directly control for availability of organic milk products.

Another initial result relates to market dynamics of organic milk products. None of the products labeled as organic prior to the new regulations were re-categorized after the label change. While all products need to be certified by a State or private agency accredited under the uniform standards developed by the USDA, unless the farmers and handlers sell less than $5,000 a year in organic agricultural products, they do not need to display the USDA organic seal. This is an interesting result in itself as part of the motivation of the NOP was based on possible misuse of the term organic, and it was expected that some products would not be able to carry the organic product specification post implementation. Based on our sample and the fluid milk market, we do not find evidence of that. Products only varied in their display of the USDA seal which allows us to identify the labeling or information effect. The coding included in the data reveals divergent strategies at the brand level regarding timing of the display of the USDA seal. This information was verified and edited before by contacting organic milk processors prior to our final estimation.

5.1 Hedonic Price Function Results

Table 3 summarizes estimates of average willingness to pay for product attributes included in the hedonic price function regressions and presents robust standard errors for those estimates clustered by brands. Three regression specifications were estimated and results mainly serve as a robustness and consistency check for estimation results in the more flexible discrete choice framework. The base model specification includes an intercept, different sizes, package materials, fat content, lactose-free product labeling, as well as the main attributes of interest with regard to organic labeling —rBGH-free labels, organic labels and the presence of the USDA organic seal. The second model specification additionally accounts for time trends in organic preferences and the third model specification estimates a log-linear functional form to transform the price changes measured in cents into percentage price changes. All three models were estimated separately for the time period prior and subsequent to the effective date on the new labeling standards.

Products that carry a USDA seal after October 21, 2002 are also indexed in the early time period to account for the possibility that they were preferred for other reasons than the added labeling information.

Table 3: Hedonic price function regression results

Hedonic price function regressions

dependent variable: price (measured in cents and adjusted for size, feature and coupon)

independent variables	1 (base model)		2 (organic time trend)		3 (log price)	
	before NOP	after NOP	before NOP	after NOP	before NOP	after NOP
intercept	264.339 ***	263.002 ***	263.970 ***	263.002 ***	5.537 ***	5.537 ***
	3.692	4.349	3.680	4.349	0.012	0.015
no rBST label	22.427 ***	36.832 ***	22.320 ***	36.832 ***	0.096 ***	0.143 ***
	5.411	7.561	5.428	7.561	0.016	0.021
organic label	192.310 ***	224.209 ***	153.065 ***	224.209 ***	0.394 ***	0.458 ***
	20.688	13.257	18.613	13.257	0.024	0.038
organic label*year			33.094 ***		0.052 ***	
			6.915		0.015	
USDA seal	35.639	62.984 ***	31.069	62.984 ***	0.006	0.114 ***
	25.004	14.121	22.566	14.121	0.041	0.042
other controls						
size (half gallon)	154.936 ***	157.346 ***	155.260 ***	157.346 ***	0.481 ***	0.491 ***
	6.279	4.813	6.278	4.813	0.016	0.015
package material (carton)	-8.895	11.831	-9.176	11.831	-0.015	0.022
	6.788	8.613	6.776	8.613	0.015	0.018
fat free	-36.119 ***	-42.217 ***	-35.578 ***	-42.217 ***	-0.123 ***	-0.146 ***
	4.830	5.859	4.773	5.859	0.016	0.021
low fat	-3.513	2.790	-3.101	2.790	-0.012	-0.007
	4.161	5.299	4.159	5.299	0.013	0.016
lactose free	307.874 ***	301.161 ***	307.783 ***	301.161 ***	0.583 ***	0.566 ***
	6.389	12.708	6.389	12.708	0.012	0.022
R squared	0.6758	0.7228	0.6758	0.7228	0.6298	0.6504
Number of observations	27526	12815	27526	12815	27526	12815

Note: robust and clustered (by brand) standard errors are reported, *, **, and *** denote values that are statistically different from 0 at the 10%, 5% and 1% level.
USDA prior to organic standard just indicates the organic products that later carry the standard
NOP=National Organic Program

Overall, the estimated regression coefficients indicate that consumers are willing to pay a premium for half gallon containers, whole fat content and lactose-free milk, as well as for all of the labels that address health and environmental related concerns. Depending on the regression specifications, some consumers are willing to pay an extra 192 cents for milk labeled as organic, which increases to 224 cents in the period following labeling changes. These price premiums correspond to a 39.4% and a 45.8% price increase as estimated in the third model specification. Products that carry the USDA organic seal do not significantly differ in terms of price premiums from organic milk prior to the implementation of the NOP, but consumers are estimated to pay an extra 63 cents once the seal was added to milk containers. This estimate is about twice as large as the estimated yearly organic time trend in the second specification and amounts to an 11.4% price increase.
Milk that carries an rBGH-free label is estimated to sell at a price premium of 22 cents (9.6%) prior to the implementation of the NOP. This premium increases to 37 cents (14.3%) post introduction.

5.2 Logit Results

Estimation results based on logit regression specifications are presented in Table 4. Product prices that are adjusted for size, sales and coupon use, and first stage residuals that address potential endogeneity of these prices, are added to the product attributes used in the hedonic regressions. In relating final regression specifications back to the comparison of random utility differences in equation (3), it is important that the absolute level of utility is irrelevant to the household's choice. The choice probability depends only on differences in utility. Therefore, not all of the parameters can be identified from the data. Only differences across products can be investigated, such that the product specific utility of one product is normalized to zero. In the regression specification, this reference is defined as a private label gallon of whole conventional milk sold at the biggest supermarket included in the data. Related to this issue is the scaling parameter implied by a normalization of the error variance in the derivation of the underlying logit formula. The true error variance can be expressed as a multiple of the normalized variance, and the estimated coefficients indicate the effect of each observable variable relative to the variance of the unobserved factors.[17] Marginal rates of substitutions are not affected by this scaling, since the scale parameter drops out of the ratios. Marginal effects are reported in Table 4 rather than the actual regression coefficients and a comparison of results across specifications need to look at ratios of these effects e.g. relative to the estimated price effect. Five alternative model specifications that vary by inclusion of an indicator for branded products, brand and store dummies, and organic time trends, are reported and indicate that estimated effects persist even when we account for possible store and brand preferences, and a general increase in preference for organic milk over time.

[17] The error variance in the logit model is not separately identified and only information about the signs of the error terms is available post estimation.

Table 4: Logit regression results

dependent variable: choice of milk product

	1		2		3		4	
	before NOP	after NOP	before NOP	after NOP	before NOP	after NOP	before NOP	after NOP
mean	0.0352	0.0340	0.0352	0.0340	0.0340	0.0352	0.0352	0.0340
independent variables								
price (in cents)	-0.0013 ***	-0.0013 ***	-0.0013 ***	-0.0014 ***	-0.0020 ***	-0.0021 ***	-0.0022 ***	-0.0022 ***
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
no rBST label	-0.0226 ***	-0.0078 ***	-0.0656 ***	-0.0747 ***	-0.2841 ***	-0.0576 ***		
	0.0028	0.0038	0.0068	0.0146	0.0193	0.0101		
organic label	0.1285 ***	0.1325 ***	0.1199 ***	0.1125 ***	0.2928 ***	0.2995 ***	0.3189 ***	0.3209 ***
	0.0108	0.0153	0.0119	0.0230	0.0120	0.0133	0.0130	0.0143
USDA seal	0.0894 ***	0.1676 ***	0.0867 ***	0.1613 ***	0.0160	0.1538 ***	0.0107	0.1551 ***
	0.0118	0.0166	0.0118	0.0166	0.0128	0.0107	0.0126	0.0103
other controls								
size (half gallon)	0.1733 ***	0.1812 ***	0.1767 ***	0.1873 ***	0.2818 ***	0.2917 ***	0.3028 ***	0.3061 ***
	0.0111	0.0157	0.0101	0.0144	0.0104	0.0101	0.0122	0.0117
package material (carton)	-0.0044 *	-0.0094 ***	0.0081 ***	-0.0050	-0.0031	-0.0079 ***	-0.0089 ***	-0.0095 ***
	0.0034	0.0023	0.0034	0.0033	0.0031	0.0023	0.0029	0.0023
lactose free	0.0152 **	-0.0076	0.0147	-0.0033	-0.0138	-0.0096		
	0.0082	0.0083	0.0080	0.0083	0.0083	0.0087		
fat free	0.0135 ***	0.0068 *	0.0145 ***	0.0064	0.0152 ***	0.0107 ***	0.0147 ***	0.0116 ***
	0.0036	0.0036	0.0036	0.0036	0.0033	0.0032	0.0032	0.0032
low fat	0.0135 ***	0.0124 ***	0.0139 ***	0.0127 ***	0.0133 ***	0.0133 ***	0.0138 ***	0.0142 ***
	0.0029	0.0029	0.0029	0.0028	0.0028	0.0029	0.0028	0.0029
brand name			0.0469 ***	0.0728 ***				
			0.0065	0.0140				
brand dummies	No	No	No	No	Yes	Yes	Yes	Yes
store dummies	No	No	No	No	No	No	Yes	Yes
time trend (year)	No	No	No	No	No	No	No	No
pseudo R squared	0.3889	0.3809	0.389	0.4099	0.5804	0.6313	0.6327	0.6871
Number of observations	296258	153575	296258	153575	296258	153575	296258	153575

Note: Marginal effects rather than regression coeficients and robust and clustered (by household) standard errors are reported.
*, **, and *** denote values that are statistically different from 0 at the 10%, 5% and 1% level.
Estimates are not directly comparable across regressionsdue to scaling effects, such that one should look at relative effects (e.g relative to marginal effect of price increase)
Regressions are adjusted for endogeneity of prices (including first stage residuals allows to reject the null hypothesis of no endogeneity of price in all regressions)
USDA prior to organic standard just indicates the organic products that later carry the standard
NOP=National Organic Program

The inclusion of residuals from the first stage regression of product prices as a function of exogenous supply and demand shifters allows rejecting the null hypothesis of no endogeneity at the 1% significance level in a Wald test in all reported five model specifications and justifies our chosen two-step approach described in section 4.4. Model specification (2) that includes an indicator for branded products, rather than individual brand fixed effects, is used to derive estimates for changes in consumer surplus. While not accounting for individual brand preferences, this model specification allows capturing a general preference for branded products due to unobserved differences in product attributes and preferences.[18]

We estimate changes in choice probability of a certain milk product given its product characteristic. Given our data restriction in that we only observe actual purchases, these estimations are conditioned on buying at least one milk product at a given shopping trip. The relevant choice set was constructed using other households' purchases in the same store at the same month. The average

[18] An inclusion of individual brand dummies resulted in multicollinearity problems in preliminary attempts of interacting observed product attributes with observed household demographics and might suggest no systematic variation in unobserved preferences across brands beyond these attribute specifications.

predicted probability of a specific milk product choice is estimated at 3.52 % and 3.4% in the two separately estimated time periods prior and subsequent to labeling changes. As prices are measured in cents, price responsiveness of product choice as reported in this table relates to a unit increase of 1 cent. This increase corresponds to average price increase of .22%. In specification (2), an increase in price by 1 cent is estimated to decrease the average choice probability by .13%. A 1% increase in price is therefore estimated to decrease the average choice probability by .59%. Labeling a milk product as organic has significant and very sizable effects on average choice probabilities as it increases by an estimated 11.99%. And while milk products that added the USDA labeling seal after the NOP went into effect were more likely to be chosen prior to these labeling changes (8.67%) in model 2, the marginal effect almost doubled to 16.13% when consumers could observe the seal on milk containers. This difference in choice probabilities cannot be attributed to a general trend in increased organic purchases as the alternative organic milk products do not portray the same increase. Furthermore, once brand fixed effects were included, USDA labeled organic products were not more likely to be chosen prior to the labeling changes but an increase in choice probability prevailed after these products carried the USDA seal.

The estimated marginal effects for rBGH-free labels exhibit negative and significant values, and therefore indicate decreases in choice probabilities for these differentiated products at the margin. The significant but unexpected sign of this effect might indicate that consumers do not focus on these attributes as much in the investigated time period as studies of earlier time periods concluded (e.g. Kiesel, Buschena and Smith, 2005; Dhar and Foltz, 2005). This might be evidence of a limited attention span by consumers as the discussion about rBGH is not as present and recent anymore as in earlier time periods. Consumers might also view the related organic labeling information as more reliable and therefore substitute away from these products if they are concerned about the use of rBGH. Organic milk has to be rBGH-free as it cannot be produced using genetically modified materials. Often organic milk even carries an extra label to state that it was not produced using r-BGH. We code our data by specifically focusing on milk that is labeled as rBGH-free but not as organic. Furthermore, the hedonic approach indicates price premiums for this specialty milk, which suggest that some consumers are willing to pay more for this characteristic. The logit specification indicates, that on average, however, consumers do not adjust their purchases according to these labels. One could even view our result as evidence of the success of educational campaigns such as the CGFI Milk is milk campaign (see Section 2).

Table 5: Estimated consumer surplus measures

Estimated consumer surplus measures (in cents)

Estimated average consumer valuation	observations	mean	95% Confidence Intervall	
unrestricted consumer surplus	927	249.90 *** 0.379	249.160	250.57
restricted consumer surplus[1]	927	226.56 *** 0.39	225.7928	227.33
consumer surplus difference	927	23.34 *** 0.20	22.95	23.74

Note: Values are averaged across households, *, **, and *** denote values that are statistically different from 0 at the 10%, 5% and 1% level.

[1] These values correspond to the counterfactual that restricts the household choice by excluding organic milk carrying the USDA-seal .

[2] Standard errors and 95% confidence intervals were computed using a nonparametric bootstrapping procedure with 20 repetitions.

Table 5 summarizes the estimated consumer surplus measures and confidence intervals. On average, households are estimated to value the added USDA organic seal on milk containers at 23 cents. This average valuation is derived by first averaging differences in consumer surplus for each individual household and in a second step, averaging across households. The consumer surplus and compensating variation measures were derived as nonlinear functions of coefficient estimates and variable values in a simulation of restricted choice sets described in the econometric framework (see also section 4.3). The distribution of consumer surplus measures across households is graphed in Figure 4.

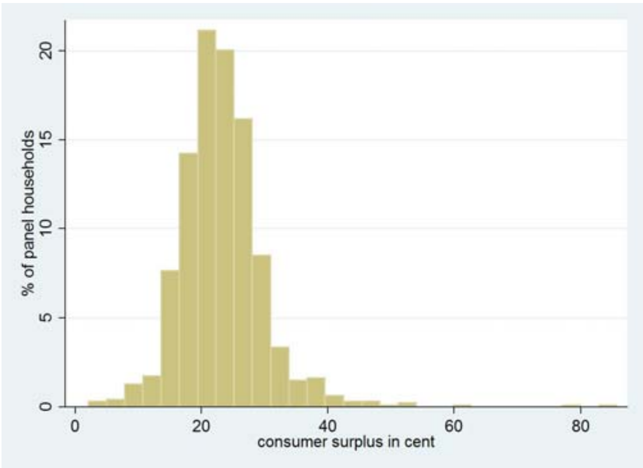
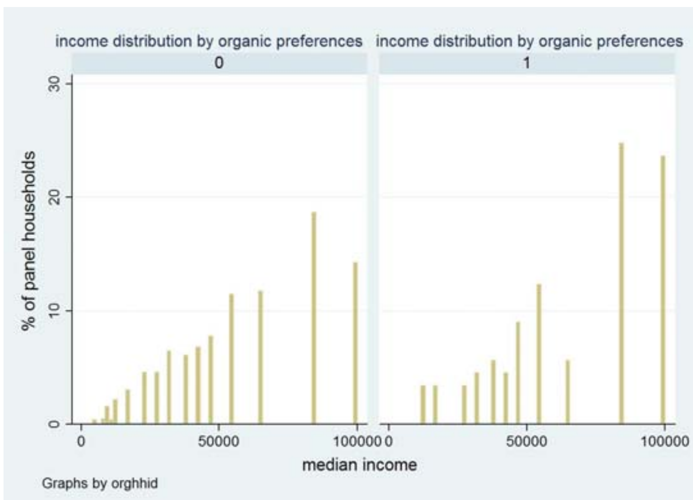


Figure 4: Distribution of estimated consumer surplus

A nonparametric bootstrap procedure was used to derive standard errors and confidence intervals reported in the same table. While these estimates range from 2 to 86 cents and as such include the hedonic price function estimate of 63 cents, they are significantly lower at the mean. The difference in value could indicate the discussed biases in the estimation of an implicit price in the hedonic approach due to sorting by consumers.

5.3 Consideration of Preference Heterogeneity

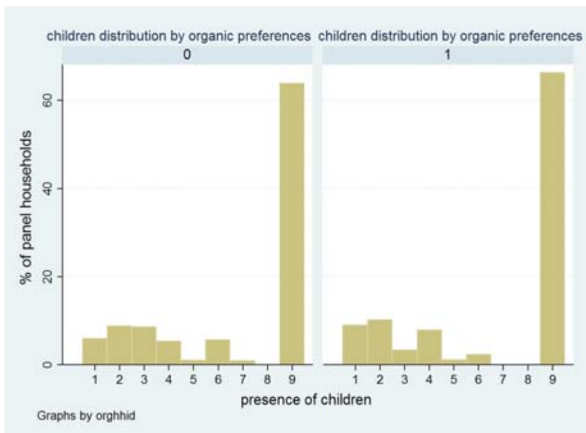
Regression results that incorporate preference heterogeneity based on observable household demographics can be motivated by distributional comparisons of observable demographics across households that purchase organic versus conventional milk. Similarly, households that purchase organic milk in general can be compared to households that purchase organic milk products carrying the USDA seal. These graphical summary statistics are presented in Figures 5 through 12.



Note: median income brackets are: 5000, 7500, 9000, 11000, 13000, 17500, 22500, 7500, 32500, 37500, 42500, 47500, 55000, 65000, 85000, 100000

Figure 5: Income distribution by organic preferences (0= conventional purchases, 1= organic purchases)

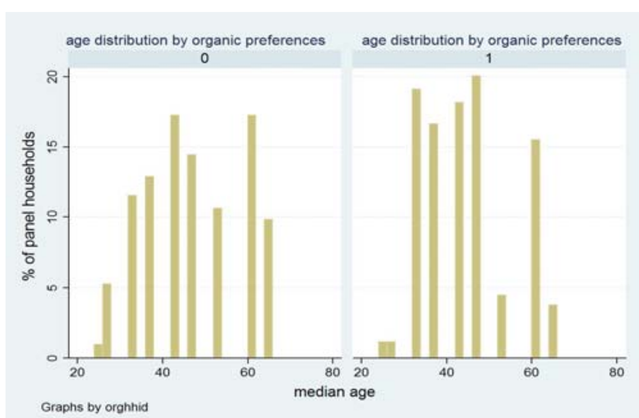
As one would expect, income levels increase preferences for organic products as they allow a household to consider additional product characteristics beyond price and nutritional value. Potential long term environmental and health risks or benefits might be of particular concern for families with children, especially families with young children. And, it could be hypothesized that younger people might be more sensitive to these issues and more likely to alter their consumption pattern than older people with well established consumption habits. When applicable, female household demographics for the female head of a household are used as women traditionally have more influence on grocery purchase decisions. Median age of the male household member is substituted if there is no female household member present. The graphs also show significant differences regarding education levels. The proportion of households with college education is significantly higher if a household considers organic production as a relevant attribute in his decision making process. This difference does not persist for post college graduates, however.



Note: Presence and age categories are:

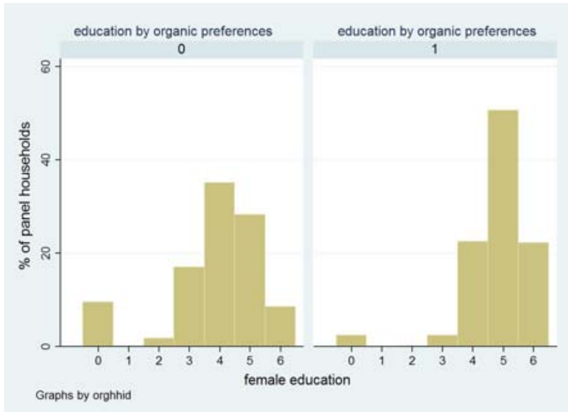
Under 6 only	1
6-12 only	2
13-17 only	3
Under 6 & 6-12	4
Under 6 & 13-17	5
6-12 & 13-17	6
Under 6 & 6-12 & 13-17	7
No Children Under 18	9

Figure 6: Presence and age of children by organic preferences (0= conventional purchases , 1= organic purchases)



Note: Median age brackets are: 25, 27, 32, 37, 42, 47, 52, 60, 65

Figure 7: Age distribution by organic preferences (0= conventional purchases, 1= organic purchases)

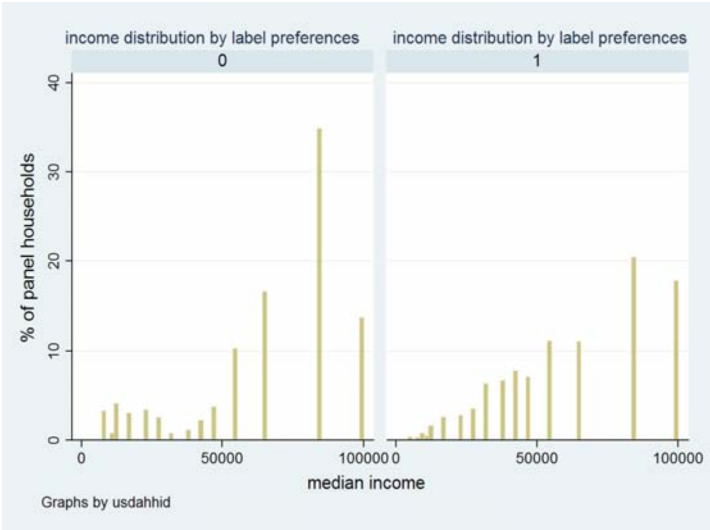


Note: Education levels are:

Grade School	1
Some High School	2
Graduated High School	3
Some College	4
Graduated College	5
Post College Grad	6
No Female Head or Unknown	0

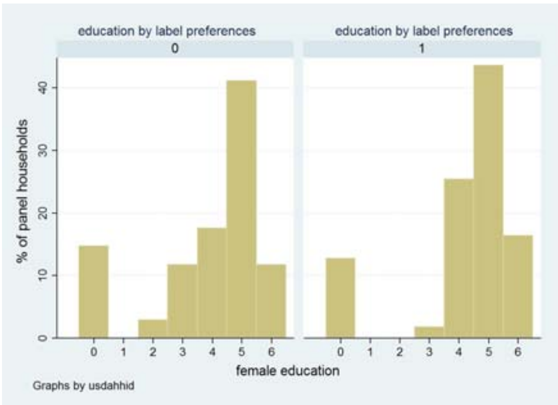
Figure 8: Levels of education by organic preferences
(0= conventional purchases, 1= organic purchases)

Regarding labeling preferences, the graphs additionally show potentially interesting differences that might relate to informational effects. With regards to household composition, single males for instance, are more likely to purchase milk with the USDA label while the same difference is not detected for single females. Households that purchase milk carrying the USDA seal include a higher proportion of single mothers on the other hand, which could mean that they were less informed about organic production prior to the NOP due to time constraints and media coverage and the USDA seal have a bigger effect on these households. Differences for more educated households are less significant in this comparison, with the main difference occurring for households graduating from high school. One could argue that the more educated are already better informed, which reduces labeling effects on these groups relative to others. There are also significant differences regarding race that might suggest that households with potentially strong ethical beliefs and consideration of animal welfare, such as households specified as oriental (e.g. Indian and Arabic nationalities), value the USDA seal.



Note: median income brackets are: 5000, 7500, 9000, 11000, 13000, 17500, 22500, 7500, 32500, 37500, 42500, 47500, 55000, 65000, 85000, 100000

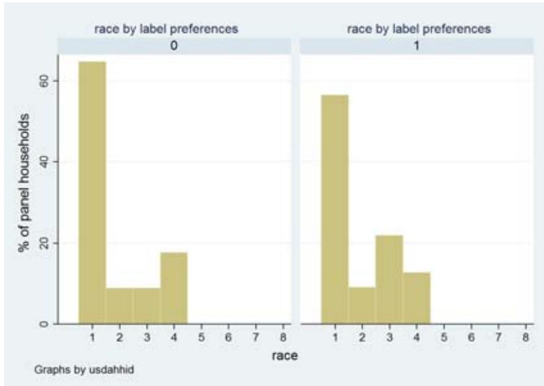
Figure 9: Income distribution by label preferences (0= organic purchases, 1= USDA organic seal purchases)



Note: Education levels are:

Grade School	1
Some High School	2
Graduated High School	3
Some College	4
Graduated College	5
Post College Grad	6
No Female Head	0

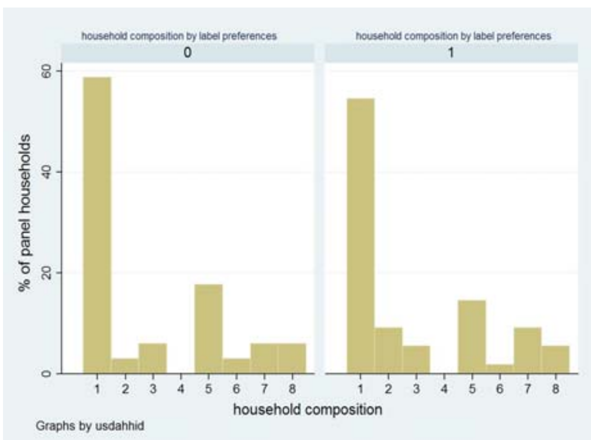
Figure 10: Levels of education by label preferences (0= organic purchases, 1= USDA organic seal purchases)



Note: Race categories are:

White	1
Black	2
Oriental	3
Other	4

Figure 11: Race distribution by label preferences
(0= organic purchases , 1= USDA organic seal purchases)



Note: Composition specifications are:

Married	1
FH Living with Others Related	2
MH Living with Others Related	3
Female Living Alone	5
Female Living with Non-Related	6
Male Living Alone	7
Male Living with Non-Related	8

Figure 12: Household composition by label preferences
(0= organic purchases , 1= USDA organic seal purchases)

All of the above distributional comparisons do not account for correlation of household demographics, however. Higher education levels for instance are likely correlated with higher income levels. Table 6 reports pair wise correlation coefficients across the household demographics considered for the regression analysis.

Table 6: Correlation matrix of household demographics

Correlation matrix of household demographics

	Income	Age	Presence of young children (under 6)	Presence of children	Education	Alternative lifestyle	Oriental race	Single mother	Single male
Income	1.00								
Age	-0.22	1.00							
Presence of young children (under 6)	0.09	-0.35	1.00						
Presence of children	0.15	-0.37	0.48	1.00					
Education	0.29	-0.19	0.02	-0.02	1.00				
Alternative lifestyle	-0.21	0.14	-0.21	-0.43	0.10	1.00			
Oriental race	0.23	-0.14	0.08	0.08	0.07	-0.09	1.00		
Single mother	-0.21	0.08	-0.06	0.10	-0.07	-0.18	-0.08	1.00	
Single male	-0.08	0.03	-0.10	-0.21	0.08	0.49	-0.02	-0.09	1

Table 7 reports regression results that account for preference heterogeneity along observable household demographics. The combined marginal effects reported in column 1 indicate that the overall average effects are robust to the inclusion of household demographics. Column 2 and 3 report the odd ratios for the included household demographics regarding organic preferences, as well as labeling preferences. A ratio greater than 1 indicates that the probability of buying organic milk, or milk that carries a USDA seal, increases for households with the specified demographics, and vice versa for a ratio smaller than 1. P-values rather than standard errors are reported to indicate statistical significance of these odd ratios. Column 2 summarizes the results of a complete set of possible demographics motivated by the graphical analysis, while column 3 includes a restricted set based on statistical significance.

Contrary to the nonparametric graphical comparison, increases in household income were not statistically significant in our specifications for either organic preferences or labeling preferences. Alternative specifications based on nonlinear functions of income, as well as a specification that only included an income interaction term in the regression, further failed to indicate significant differences for the reported income brackets. This might suggest that income does not sufficiently predict preference heterogeneity for organic production, as well as labeling preferences. Another possible explanation might be that the categorical coding in the income variable does not properly capture the relation of income and preference heterogeneity. And finally, a combination of other alternative demographics might recover this relation through correlations of these measures reported in Table 6. The information on the age of the female household head (or male household head if no female head was present), as well as an indicator for a single male living alone, further had no predictive power regarding preference heterogeneity in the regression specification.

Table 7: Logit regression with consideration of household demographics

Logit regressions with consideration of prefernce hetoergeneity

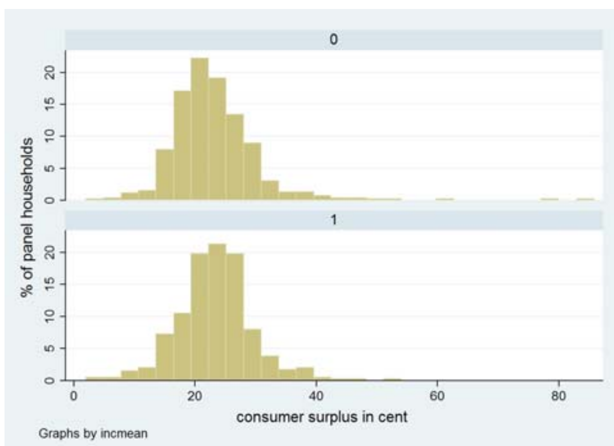
dependent variable: choice of milk product

	(2) marginal effects	(1) odd ratios	(2) odd ratios
independent variables			
price	-0.001 ***		
	0.000		
no rBST label	-0.076 ***		
	0.015		
organic label	0.103 ***		
	0.024		
USDA seal	0.165 ***		
	0.017		
other controls			
size (half gallon)	0.187 ***		
	0.014		
package material (carton)	-0.005		
	0.003		
lactose free	-0.003		
	0.008		
fat free	0.007		
	0.004		
low fat	0.013 ***		
	0.003		
brand name	0.073 ***		
	0.015		
interactions organic label			
income		1.000	
		0.415	
age		0.989	
		0.748	
young children		0.210	0.169 **
		0.110	0.049
oriental race		2.960	2.516
		0.207	0.258
years of education		1.574 **	1.510 ***
		0.011	0.002
single mother		0.065 ***	0.058 **
		0.020	0.011
single male		0.275	
		0.224	
interactions USDA seal			
income		1.000	
		0.673	
age		1.001	
		0.974	
young children		2.846	4.531 *
		0.312	0.082
oriental race		0.273 **	0.307 **
		0.037	0.021
years of education		0.840	0.840
		0.213	0.136
single mother		9.922 ***	13.364 ***
		0.000	0.000
single male		0.800	
		0.843	
pseudo R squared	0.4131	0.4145	0.4131
Number of observations	296258	153575	296258

Note: Combined marginal effects rather than regression coeficients and robust and clustered (by household) standard errors are reported in the first column. *, **, and *** denote values that are statistically different from 0 at the 10%, 5% and 1% level.Odd ratios and p-values are reported for two alternative specifications in column 2 and 3. Regressions are adjusted for endogeneity of prices (including first stage residuals allows to reject the null hypothesis of no endogeneity of price in all regressions).

Whether a household has young children (under the age of 6) influences the probability of choosing organic milk. In the long regression specification reported in column 2, this interaction term is insignificant with regards to organic preferences, but in the short regression, the presence of young children does have predictive power. However, the direction is counterintuitive as the presence of young children decreases a household's probability to buy organic milk. But, households with young children are more likely to buy organic milk carrying the USDA seal. The first effect might actually capture budgetary constraints of households with children due to increased household size, while the second effect might indicate that these households have higher opportunity costs of time and therefore profit from the informational effect of the new regulations. The same explanation would carry through when looking at the effect for single mothers. And finally, an oriental race specification also had predictive power for labeling preferences. Contrary to the graphical analysis, households with this specification are less likely to buy milk carrying the USDA seal, which again may partly capture income effects and budget constraints.

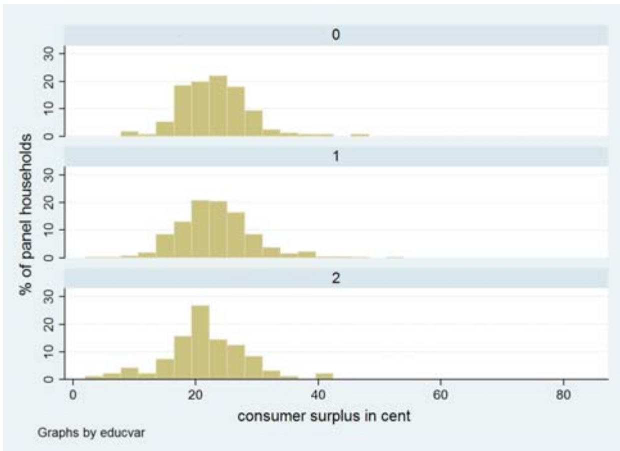
Even though, the regression specifications failed to detect the importance of increases in income in preference formation, Figure 13 recovers implicit differences of consumer's valuation for the change in labeling. For households with income levels greater that the median yearly income, the distribution of consumer valuation is slightly shifted to the right. This distributional shift is not substantial but does go in the predicted direction based on an argument of opportunity costs of time spent searching as previously discussed.



Note: The top graph corresponds to households with an income lower than the median yearly income of $55.000.

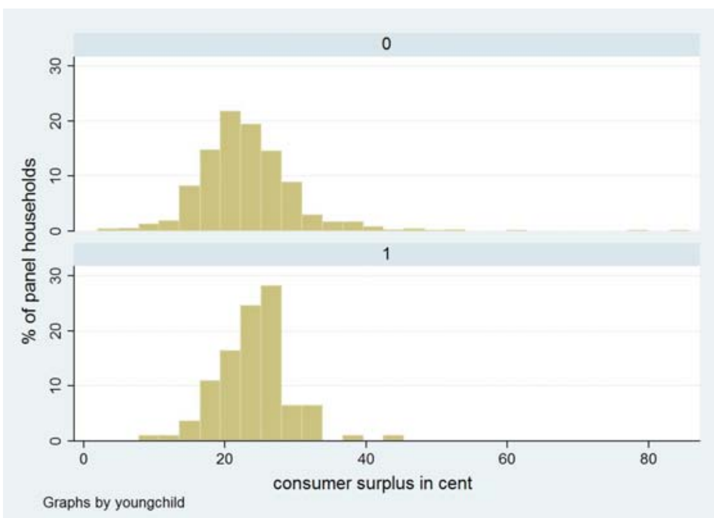
Figure 13: Average consumer valuation across households differentiated by income

Similarly, Figure 14 and 15 illustrate differences in consumer valuation due to years of education and presence of young children. Overall, distributional shifts are not very distinctive, but do suggest that higher income, higher education levels, and/or the presence of small children slightly increases benefits from the NOP and its labeling changes, an explanation consistent with our hypothesis based on time or search costs.



Note: The top graph corresponds to high school education (12 years of education and less), the middle graph corresponds to college education (16 years of education and less), and the bottom graph corresponds to post college education (more than 16 years of education).

Figure 14: Average consumer valuation across households by education



Note: The top graph corresponds to households that do not have children under 6 years old.

Figure 15: Average consumer valuation across households differentiated by presence of young children

6. Conclusions and Future Research Extensions

This paper empirically investigates how changes in information provision regarding organic production under the NOP may have altered consumer purchase decisions of fluid milk products. Detailed purchase data over a four year period (2000-2003), including household demographic information of purchasing individuals, are used to estimate an initial hedonic price function that also serves as a consistency check for estimates in a more flexible discrete choice model. A conditional logit specification is used and supported by the characteristics of our data. This specification allows for a straightforward subsequent simulation of restricted choice sets to estimate consumer valuation of the NOP.

Our results suggest that consumer purchase behavior is significantly affected by the NOP and the appearance of the USDA organic seal on milk containers. Estimates of average consumer valuation of the USDA seal in the hedonic price function approach resulted in higher estimates than simulations of restricted choice sets within a logit framework. These differences might stem from biases in the hedonic approach discussed in the literature (e.g. Chay and Greenstone, 2005) as consumers sort themselves according to their marginal willingness to pay. The graphical analysis of distributional differences in household demographics gave a first insight into preference heterogeneity and motivated the chosen patterns for an inclusion of household demographics in the logit model. Overall, observable household demographics seem to be only partially able to capture preference heterogeneity with regards to organic production and information changes due to labeling. The estimated average consumer valuation of 23 cents per milk product choice is not significantly affected by the inclusion of household demographics and distributional differences in estimated consumer valuation measures are not very persistent.

Aggregating the average estimated consumer valuation by an average purchase of 1.12 gallons of milk per shopping trip found in our data and applying the sample average annual consumption of 34.91 gallons of milk, or alternatively, the population average milk consumption of 23 gallons respectively (USDA ERS, 2003) yields an average annual benefit of $7.24 or $4.77 per household. Further aggregating this estimate by current population measures of 290,850,005 (US Census, 2006) yields an estimate of annual consumer welfare of $2.106 billion based on the sample average, or $1.387 billion based on the population average. This sizable consumer benefit can be contrasted with the estimates of labeling regulations the USDA provided: The estimated costs of accreditation and labeling under the National Organic Program (NOP) alone were stated to approach $1 million and $1.9 million, respectively. A number of other potential costs such as enforcement, record keeping, and production and handling costs are also discussed but not quantified (USDA, 2000). In conclusion, and as a result of this analysis, the estimated welfare based on consumer valuation of labeling changes alone seems to outweigh the costs incurred by this regulation. We find empirical support for the involvement of the USDA in developing uniform and standardized labeling guidelines.

We are currently working on extensions to the present analysis by looking at interdependencies of prior media coverage and the actual appearance of the USDA seal on milk cartons using additional data. Furthermore, we would like to compare and contrast the estimated labeling effects and its interdependencies with media coverage, advertisement and marketing efforts by producers and processors to findings in the context of nutritional labeling in future studies. As Ippolito and Pappalardo (2002) for instance suggest, regulatory rules and enforcement policy might have induced firms to move away from reinforcing nutritional or health claims and might have ultimately reduced consumers' attention for nutritional choice determinants. Organic labeling and the USDA seal seem to have boosted an already growing specialty food segment and initiated the movement of organic into mainstream.

A better understanding of informational effects on consumer behavior in general, and the interplay between regulation, media coverage, and product marketing more specifically can determine which regulatory tools best serve consumers interest and policy objective at the same time. We want to identify successful and efficient strategies and guidelines for informational policies aimed at influencing or altering consumers' choices. Findings are relevant beyond the assurance of accuracy of labeling claims on specialty foods and applicable to public health problems such as growing obesity rates, for instance. Research in this area provides valuable insights to policy makers, marketers and food retailers alike.

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